Earth System Research Laboratory
Physical Sciences Division

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NATIONAL INTEGRATED DROUGHT INFORMATION SYSTEM

South-Central U.S. Droughts, La Niña, and Other Factors

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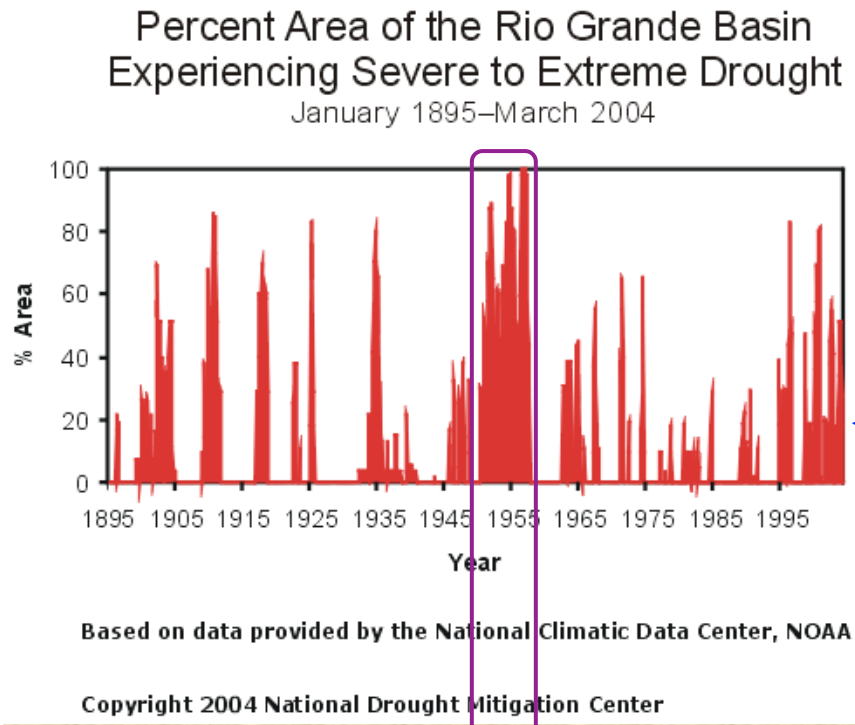
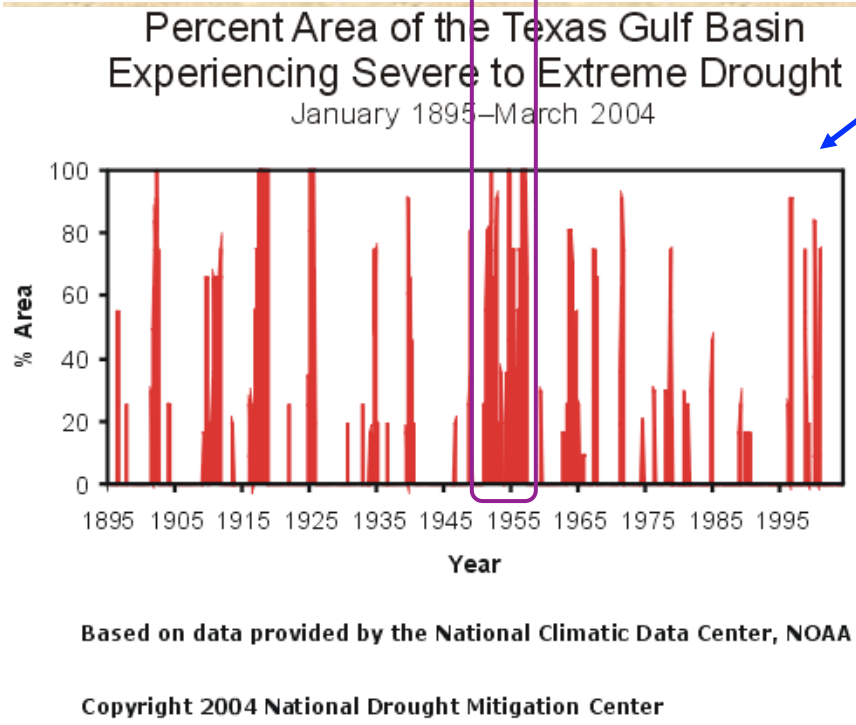
Kudos to Marty Hoerling, Jon Eischeid, and Barb DeLuisi (NOAA-ESRL)

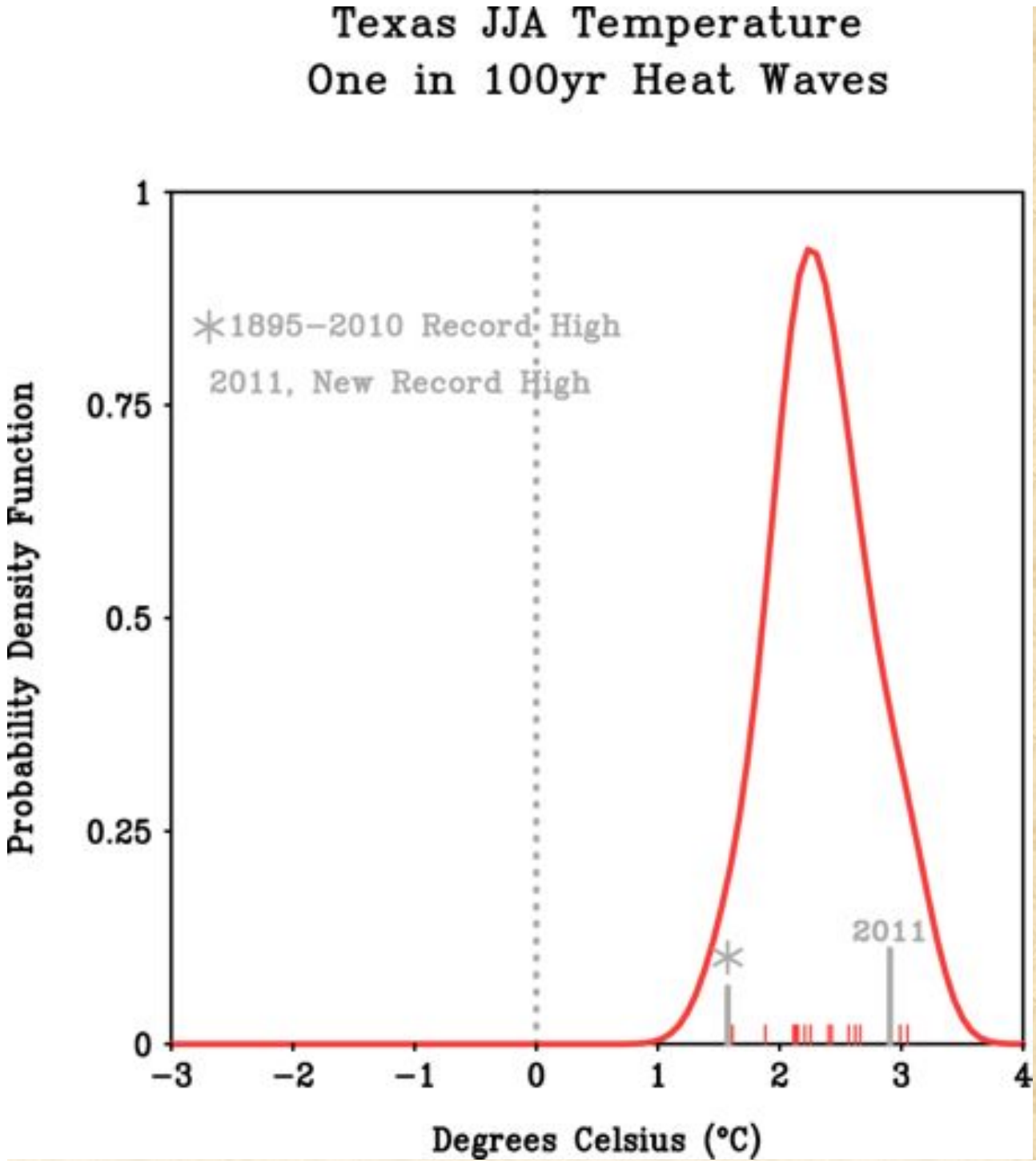
- **Background material on droughts in this region**
- **Current ENSO setup and outlook into summer**
- **Other factors**
- **Next winter?**





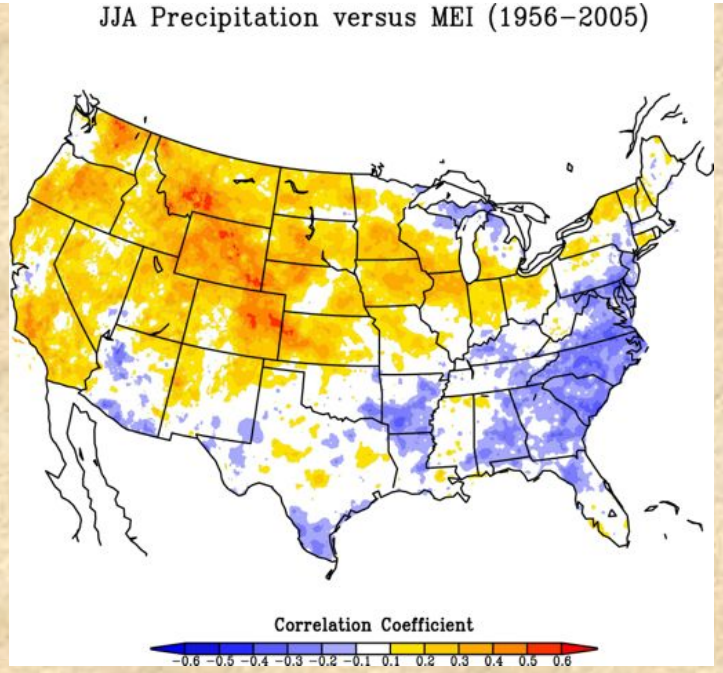
A quick look at Texas drought history: the 1950s 'Drought of the Century' was anchored by repeated La Niña conditions, and was much more prolonged than other droughts of the last century (2011-12 was the most severe one-year drought).

Top ten TX droughts (Oct-Jun) were ALL associated with La Niña (2011, 1925, 1956, 1971, 1996, 1917, 1967, 1918, 1951, 2006)!



The nature of 100-year events

Source: Hoerling et al., 2012: Anatomy of a Heat Wave. J. Climate, submitted



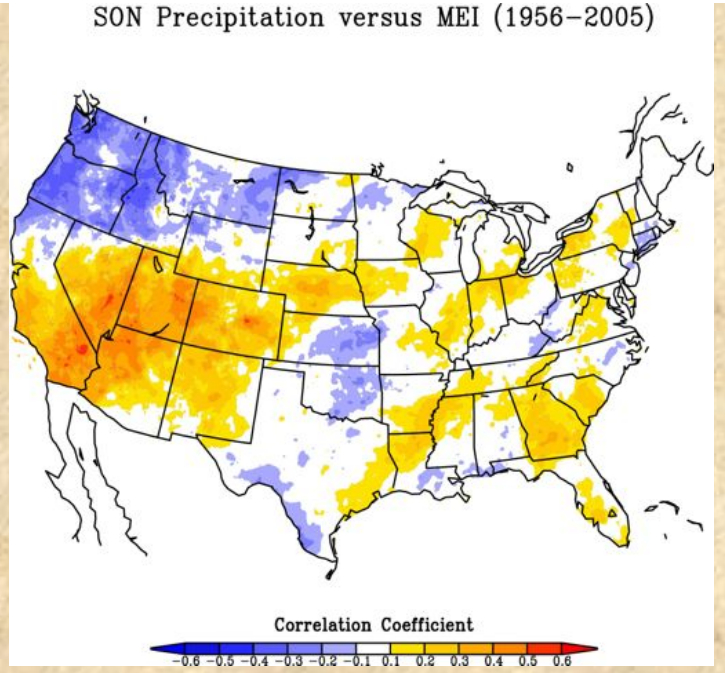
Seasonal cycle of ENSO impacts

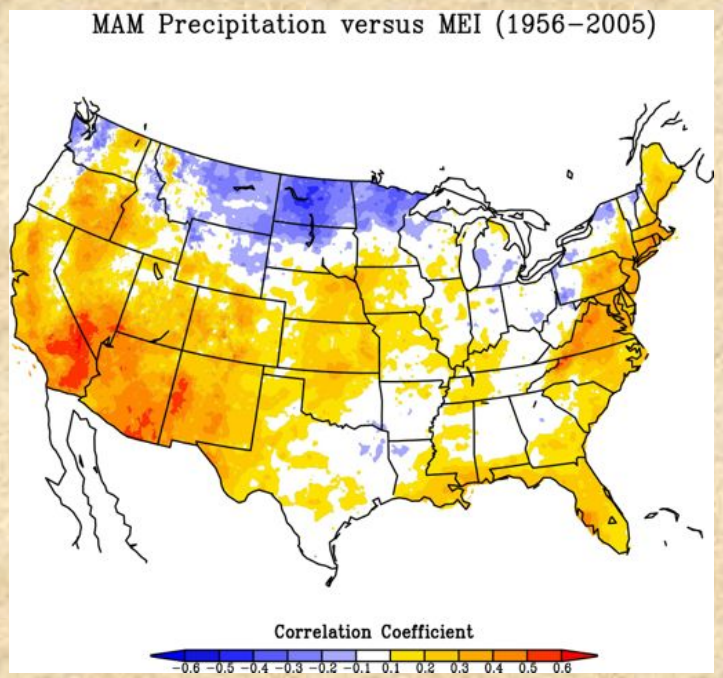
New Mexico has <u>positive correlations year-round</u>, especially in winter and spring (bottom panels).

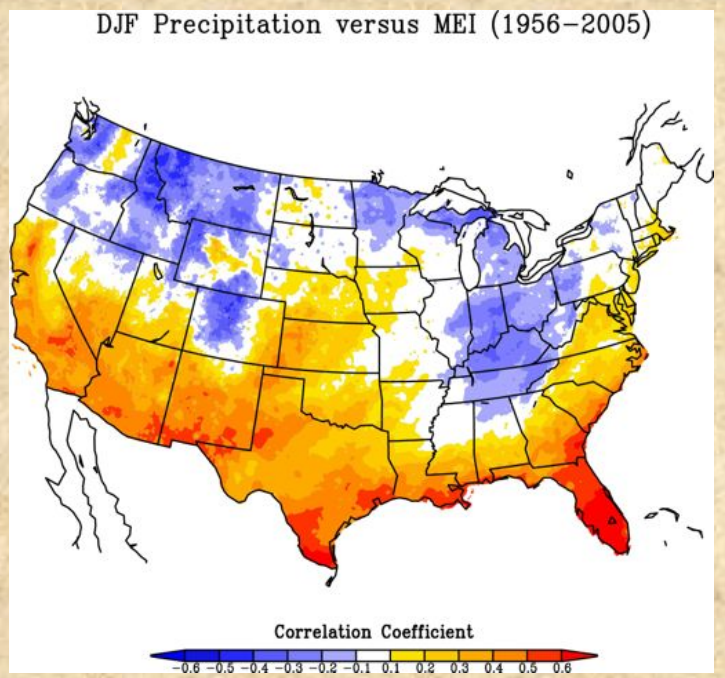
Texas correlates highest in winter. <u>Summer and fall are barely constrained by phase of ENSO.</u>

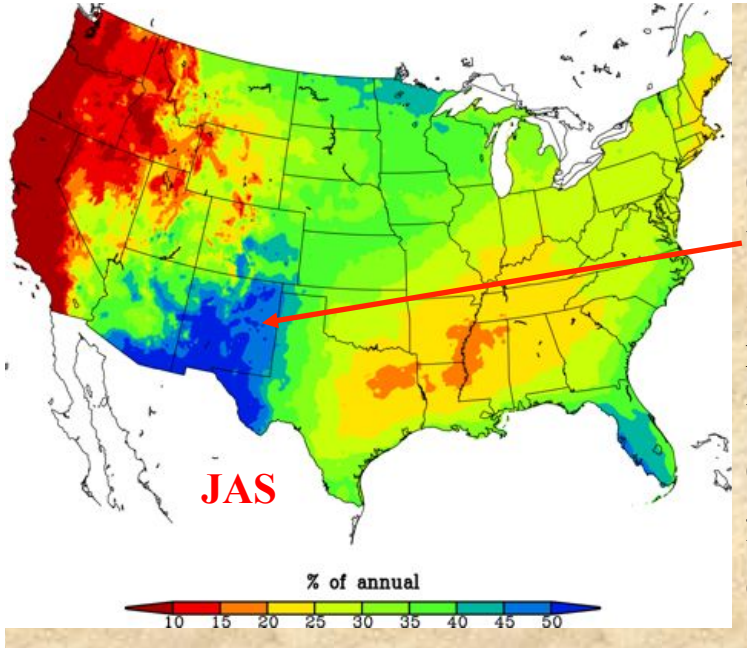
Oklahoma shows <u>negative correlations in fall</u> (top right), while the other three seasons favor positive correlations, especially in winter.

Σ: La Niña favors drought!





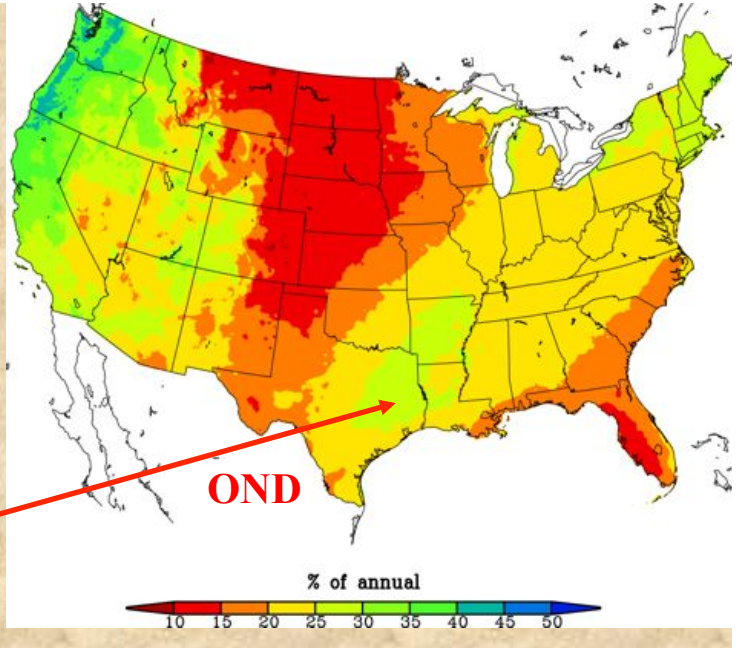


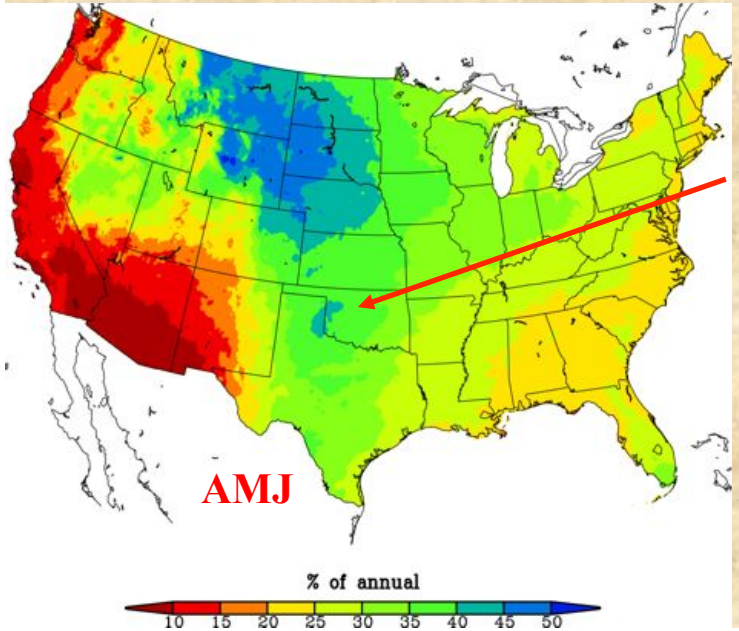


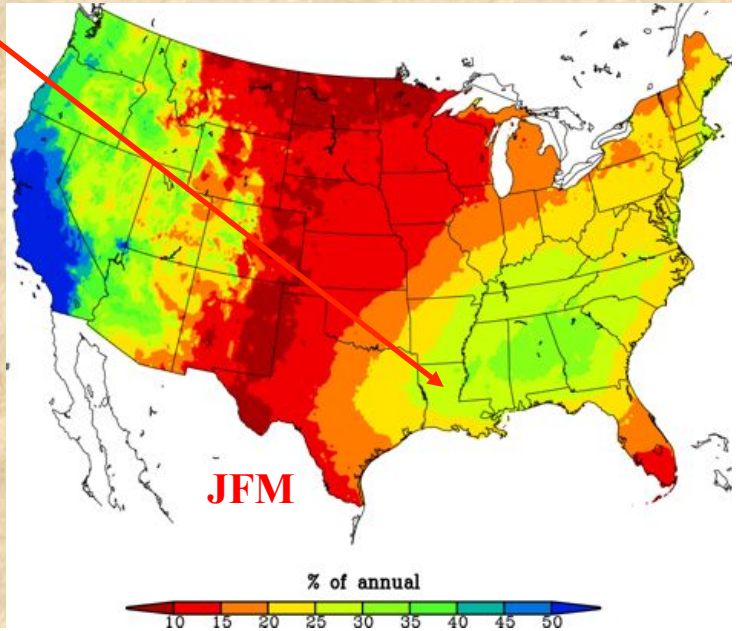
Seasonal cycle

Summer monsoon (top left) contributes up to 50% of the annual precipitation in NM, but is quite unimportant from eastern TX into LA; fall season (top right) contributes > ¼ of annual totals over eastern TX; winter (bottom right) is most important in LA; spring (bottom left) is key season from eastern NM eastwards.

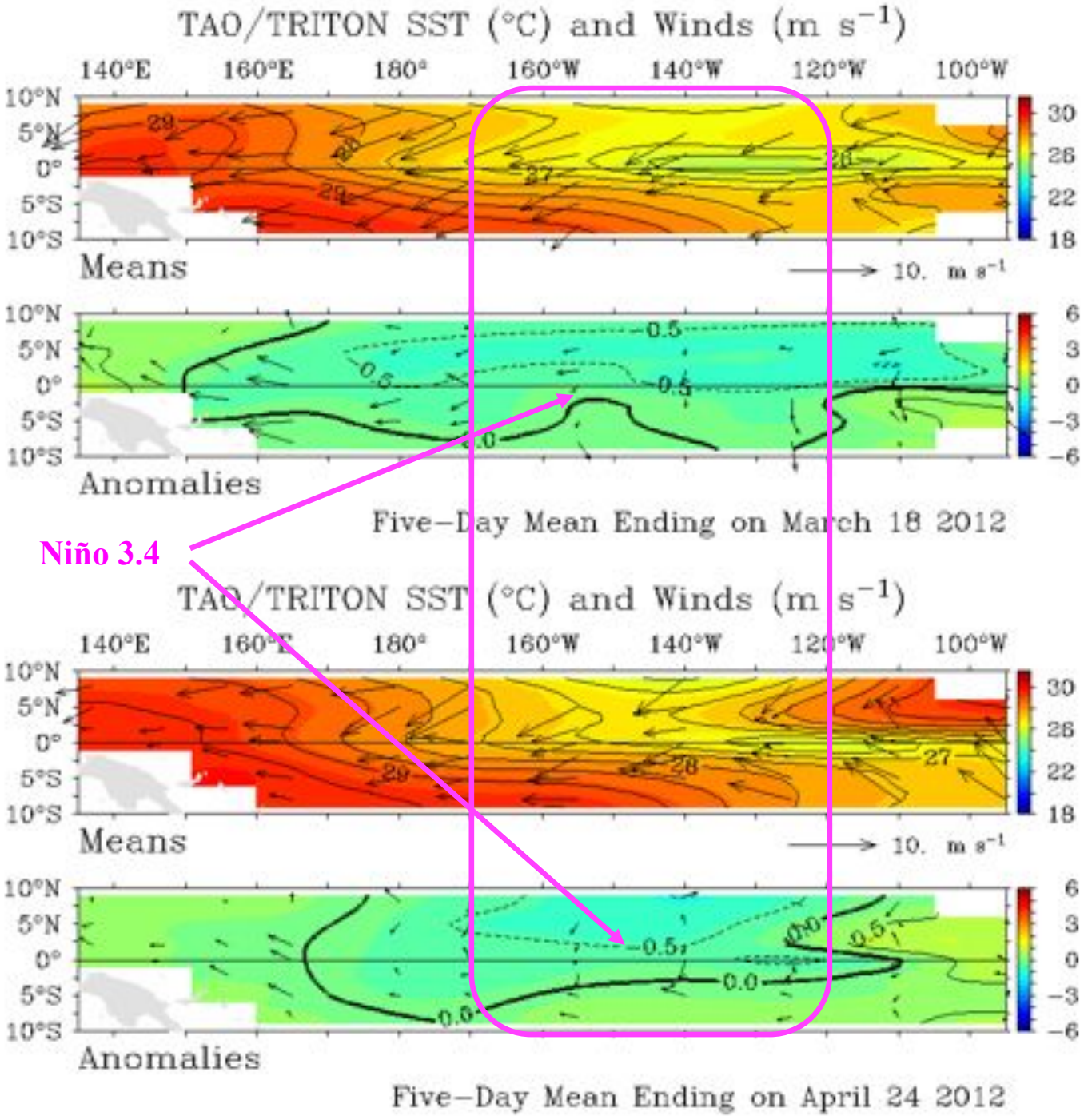
NOTE: It is easiest to get into or out of droughts during the wettest season of the year!

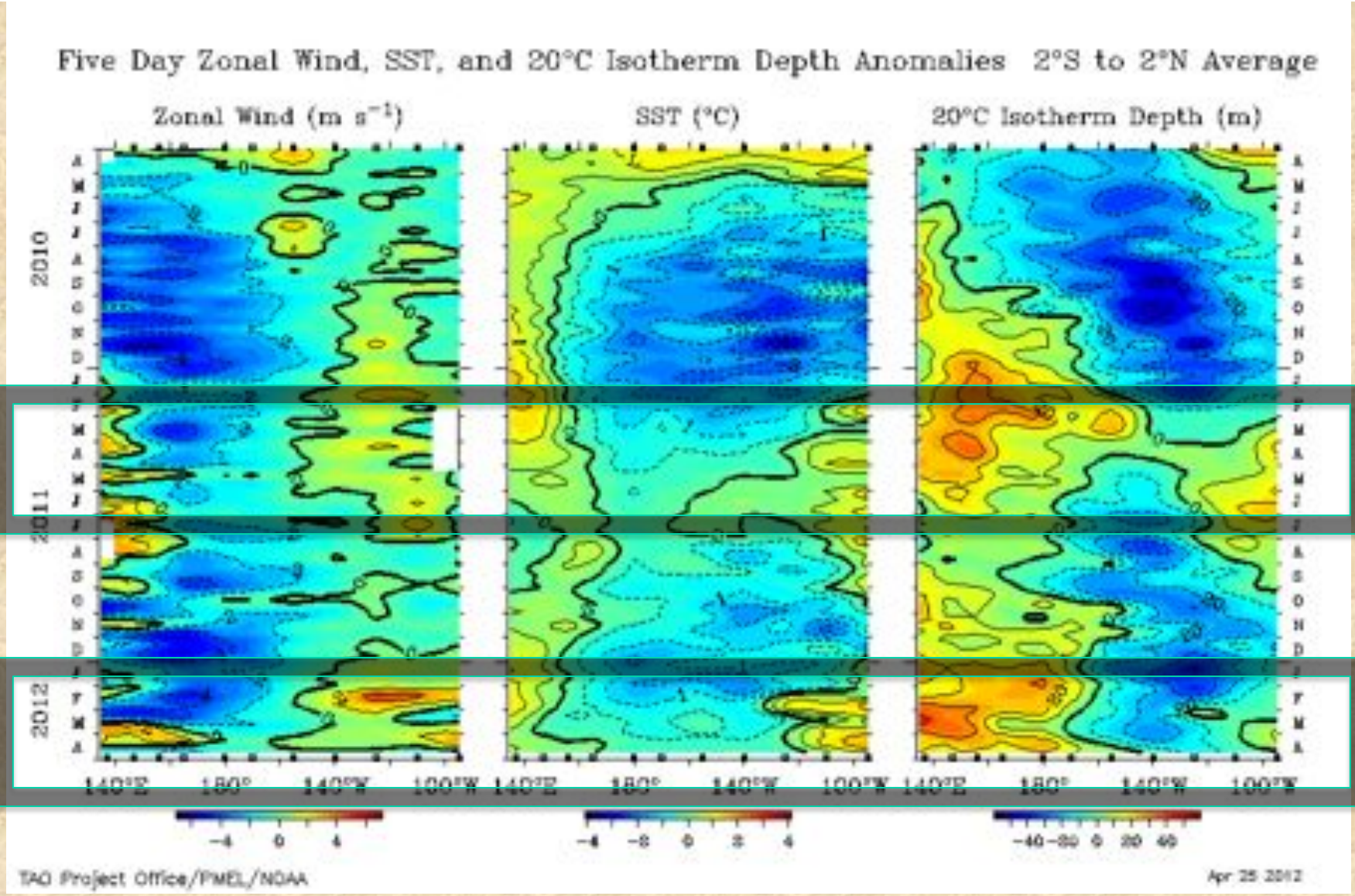




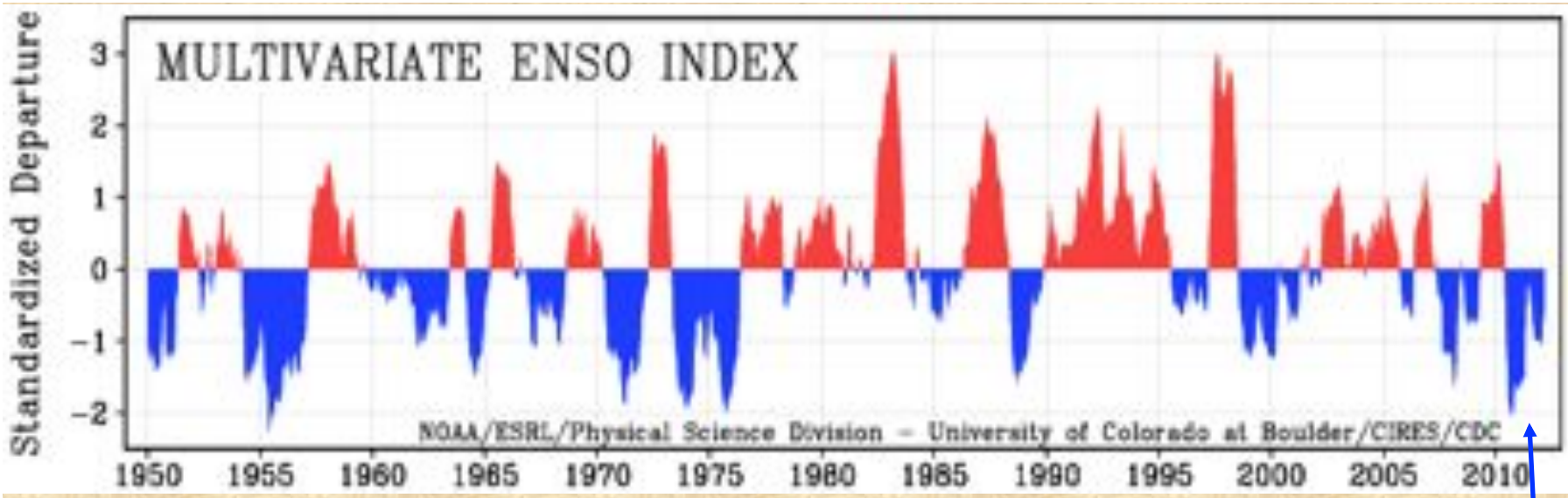


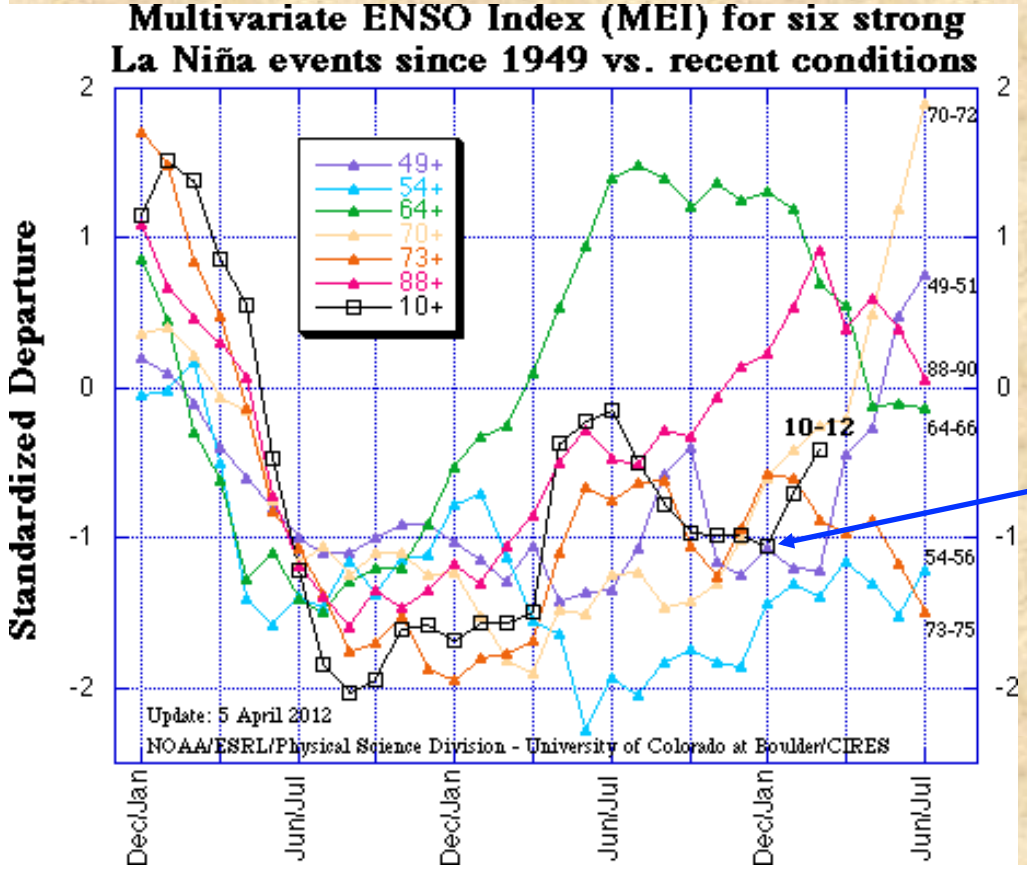
Current state of El Niño/Southern Oscillation (ENSO) phenomenon (bottom), compared to last month (top): La Niña has weakened. This includes smaller equatorial SST anomalies, and growing positive SST anomalies in eastern tropical Pacific. Trade winds near and west of dateline are not as strong as they were just a month ago.





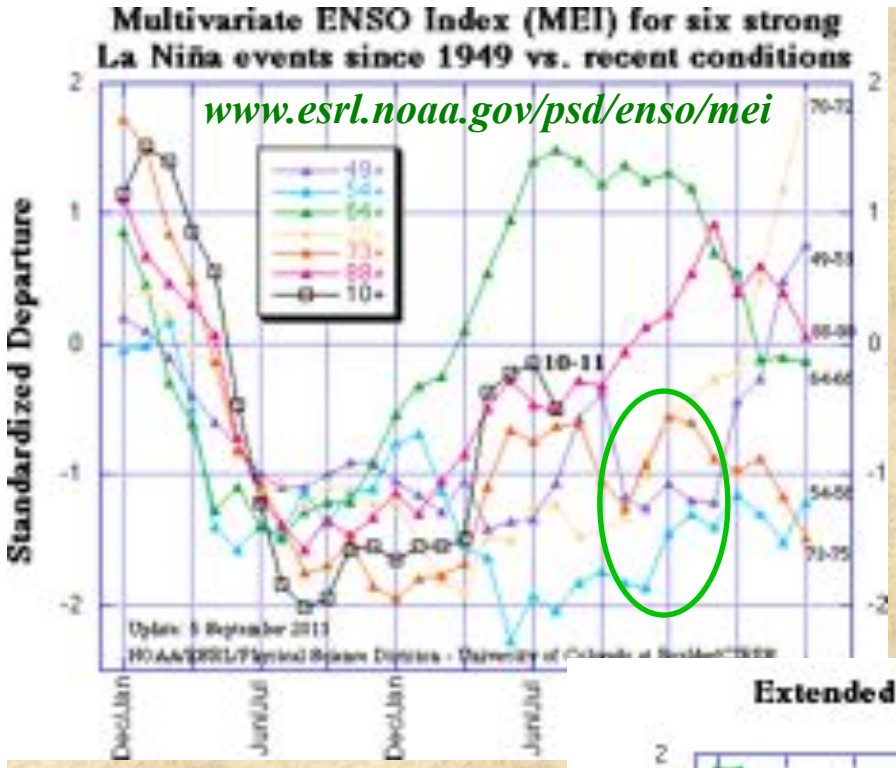
Zonal cross-section for east-west wind (left), SST (middle), and upper ocean heat content (right) shows the evolution of the 2010-12 La Niña (*quite a few similarities with one year ago*).





Current La Niña event reached its first peak in late 2010, followed by a brief excursion to ENSO-neutral conditions during mid-2011; it reached a second peak just a few months ago.

http://www.esrl.noaa.gov/psd/enso/mei



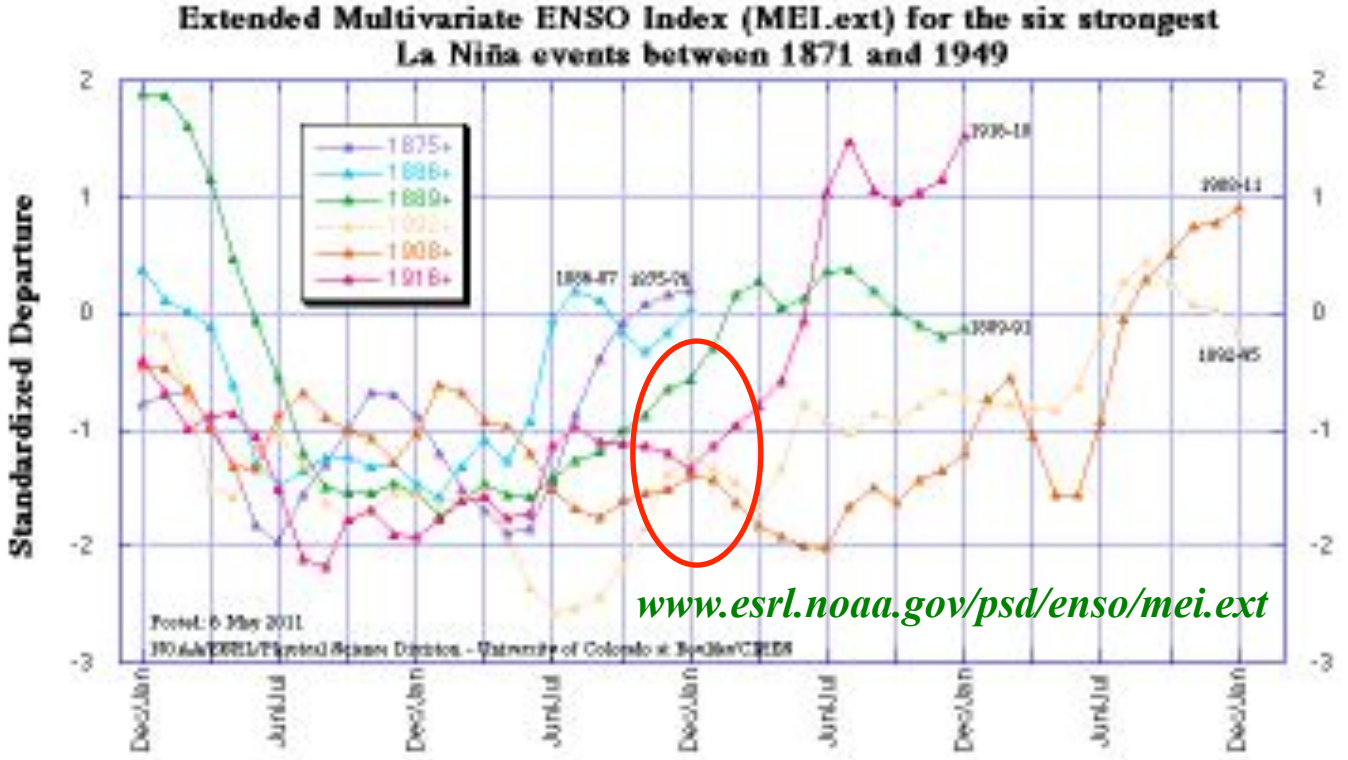
Big La Niña events tend to linger…

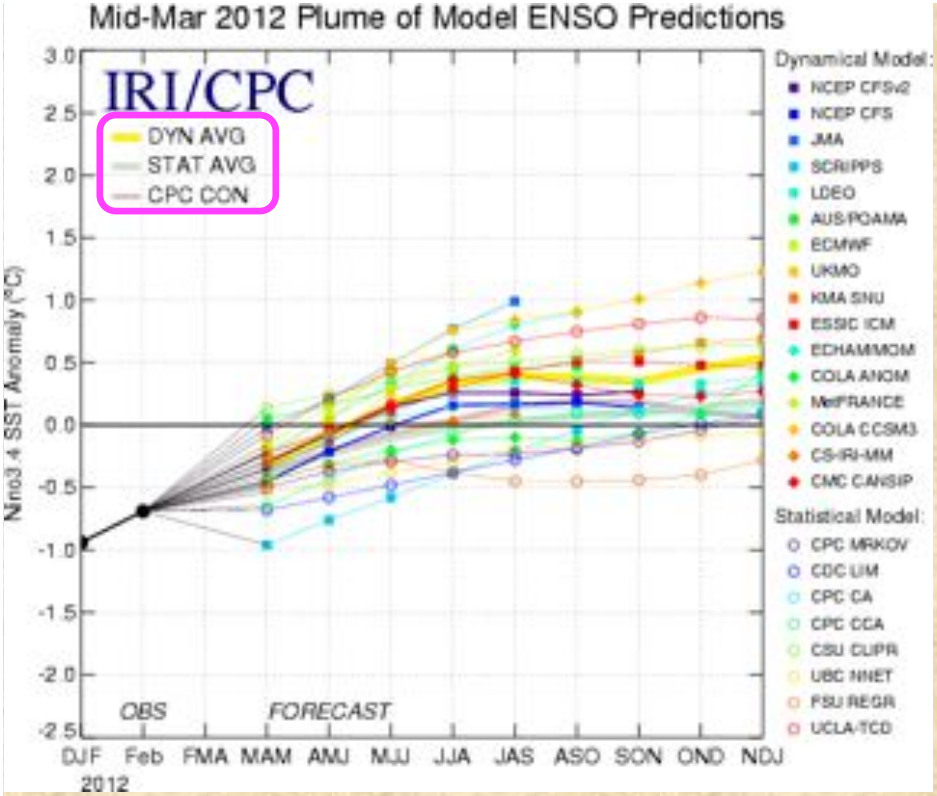
Only 1964-65 returned to El Niño within a year!

Odds are about 2:1 for large Las Niñas to get double-dip (2nd year event), both pre-1950 and since then…

<not nearly as common for Niños – biggest ones 'self-destruct'>

Ten 'Double-dip' (***'triple-delight'***) Las Niñas in last century before the current one: **1908-11**, 16-18, *21-23*, 49-51, **54-57**, *61-63*, 70-72, **73-76**, ***1998-2001***, *2007-09*



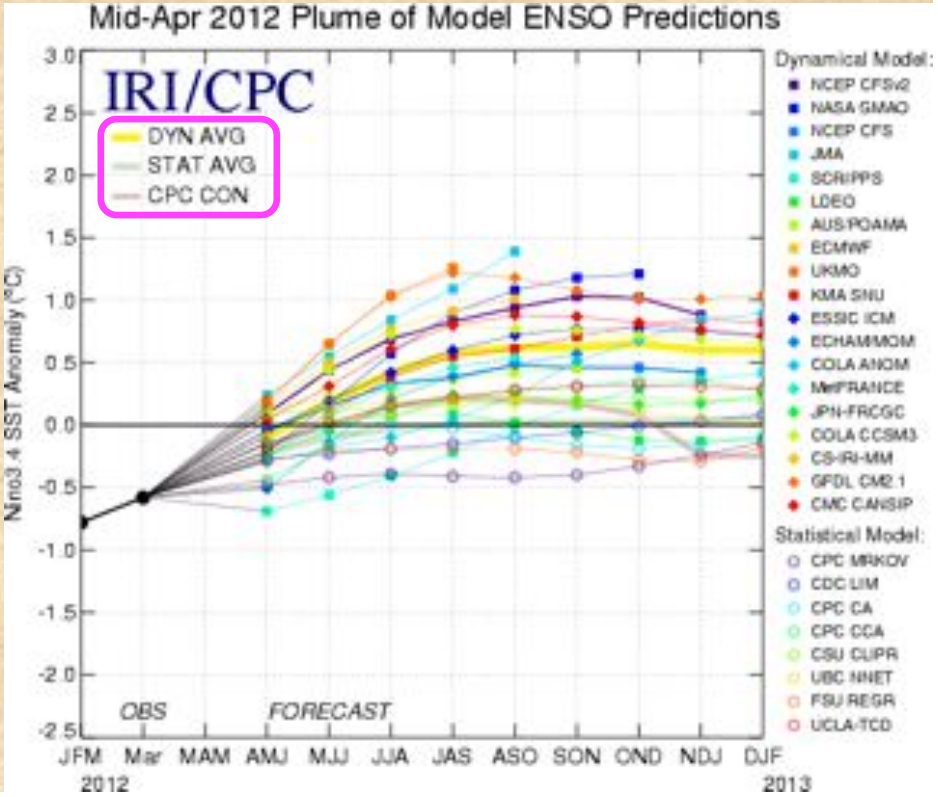


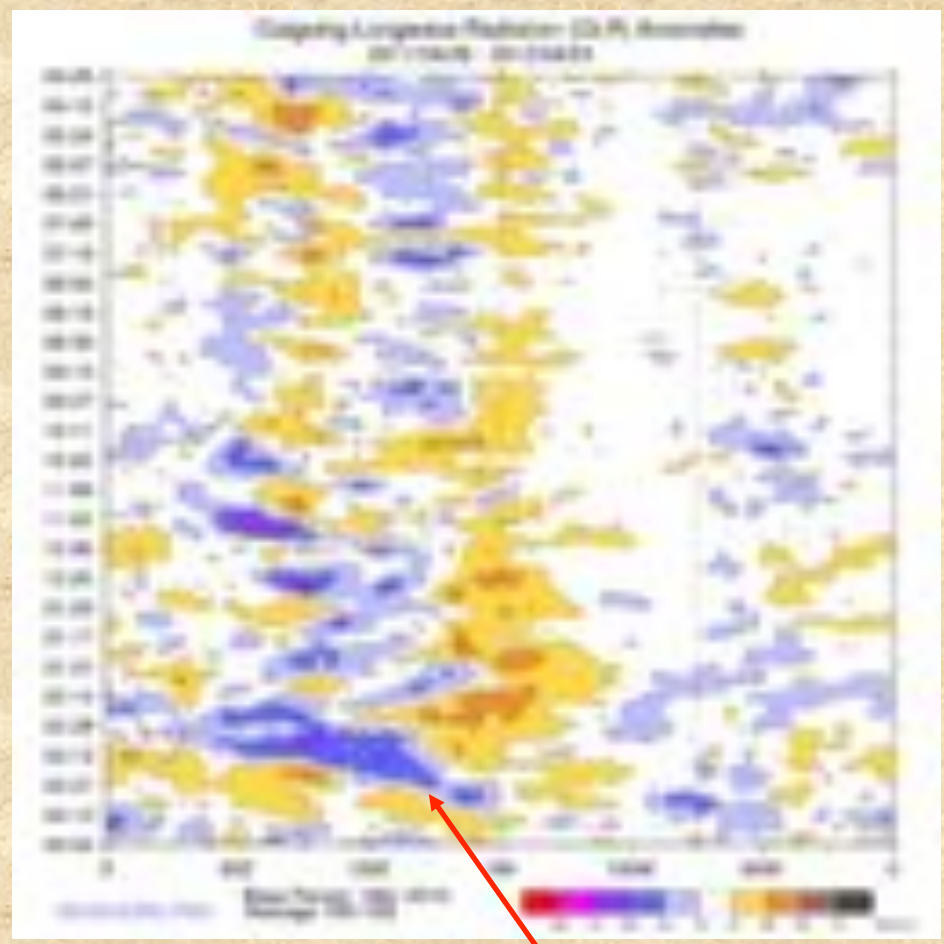
ENSO forecasts from 16 dynamical & 8 statistical forecast models from last month (left):

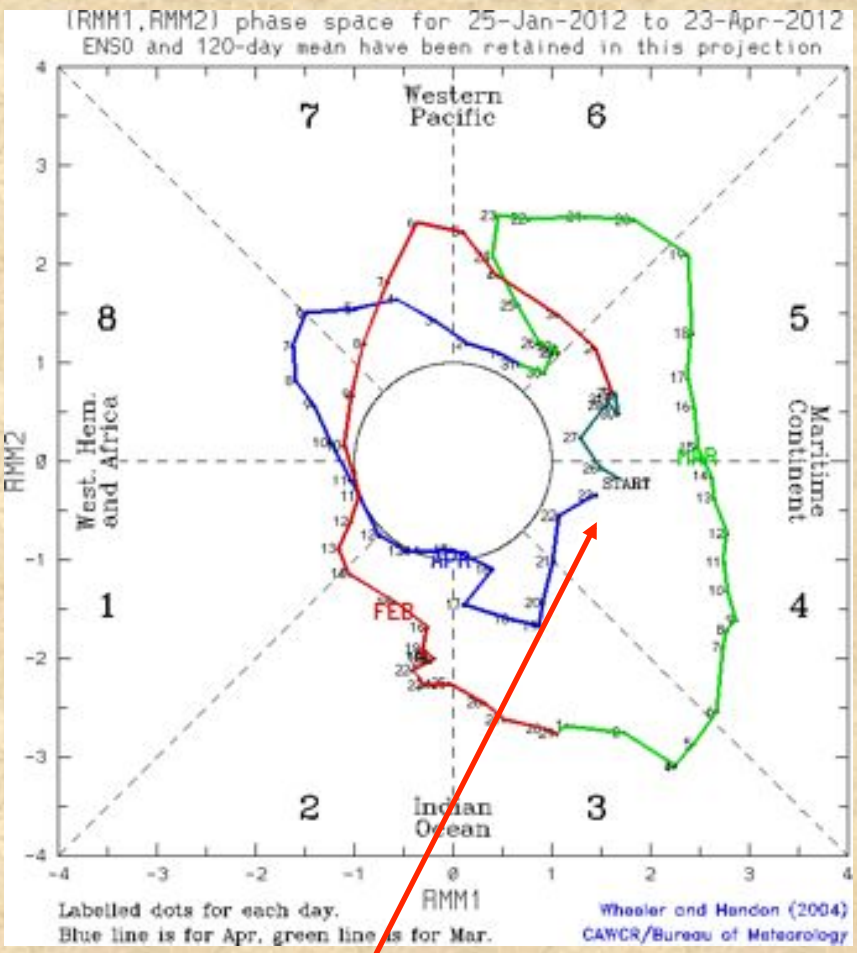
Expect ENSO-neutral conditions by late spring 2012, but beware of unusually weak scatter for this time of year...

On average, dynamical models warmer than statistical models – the latter do not 'see' MJO's.

The most recent forecasts (right) show much more of a shift towards El Niño than the statistical models, and a more pronounced tilt towards El Niño than last month's forecasts. In fact, the majority of dynamical models show El Niño conditions from 'JAS' onwards, while none of the statistical models reach that level.

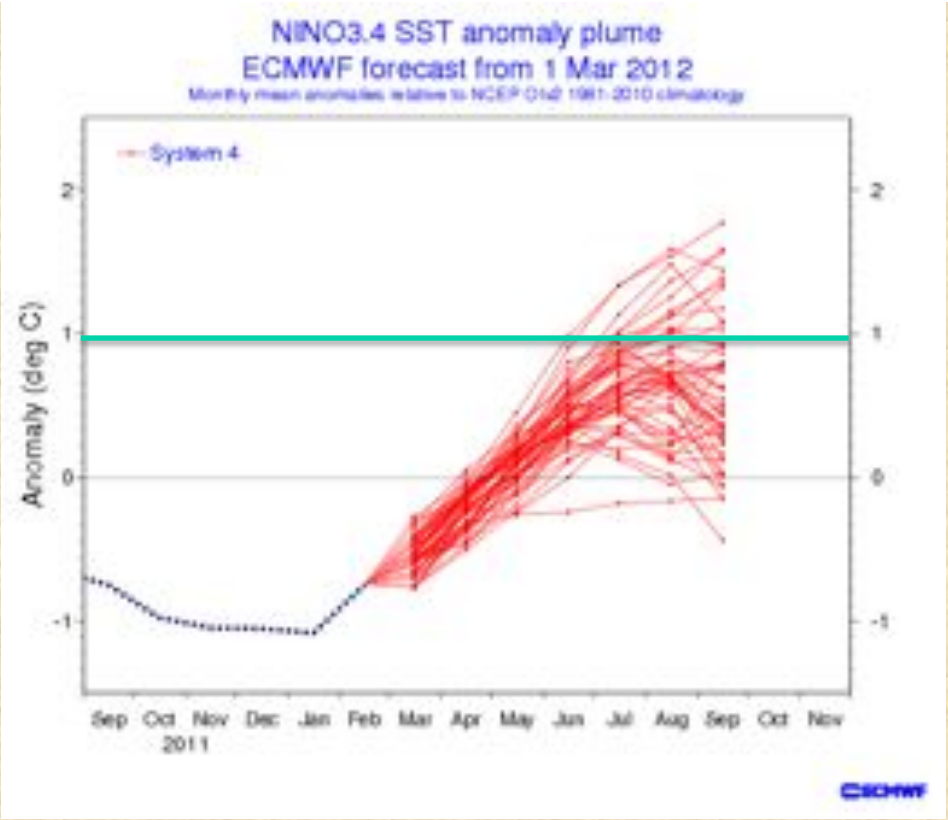




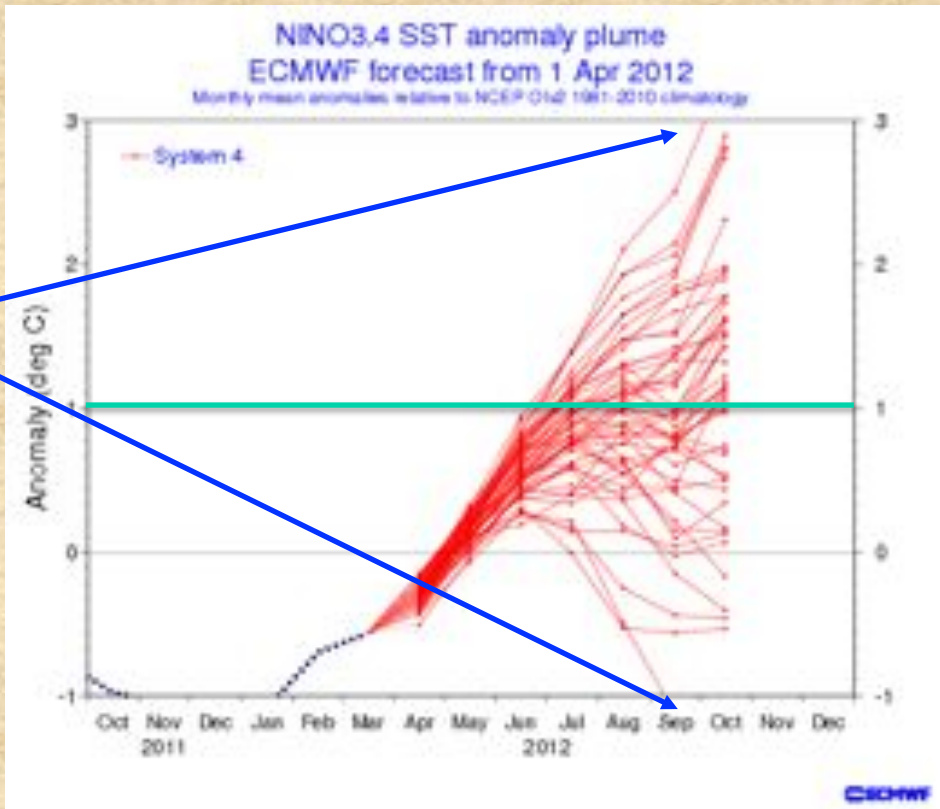


One factor that is very different from last year: Intraseasonal tropical activity ('MJO') is much enhanced compared to last year, although that by itself does not 'cause' a switch to El Niño, it can be big contributing factor ('Hail Mary Pass' to El Niño)!

It certainly increases volatility in climate forecast models!



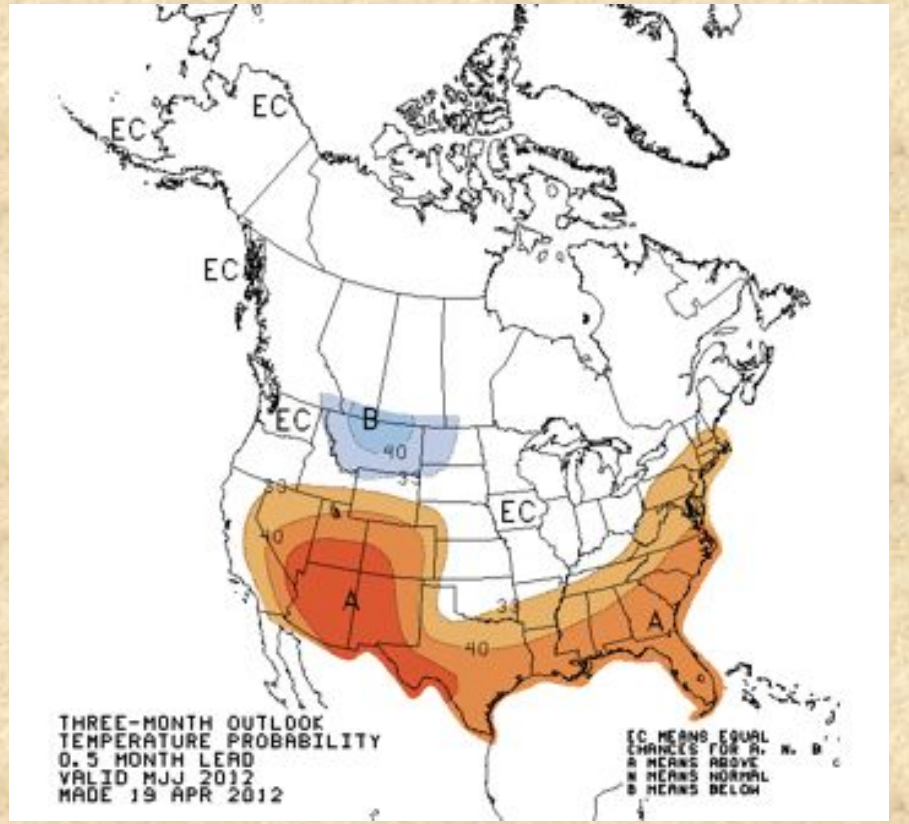
The March 2012 ECMWF forecast (left) showed a fairly dramatic transition *towards* El Niño during the next six months; the majority of the 50 ensemble members ('spaghetti plot') reached at least weak strength (+0.5°C) at some point during our summer, while about five members hinted at a return of La Niña (<0°C) by September.

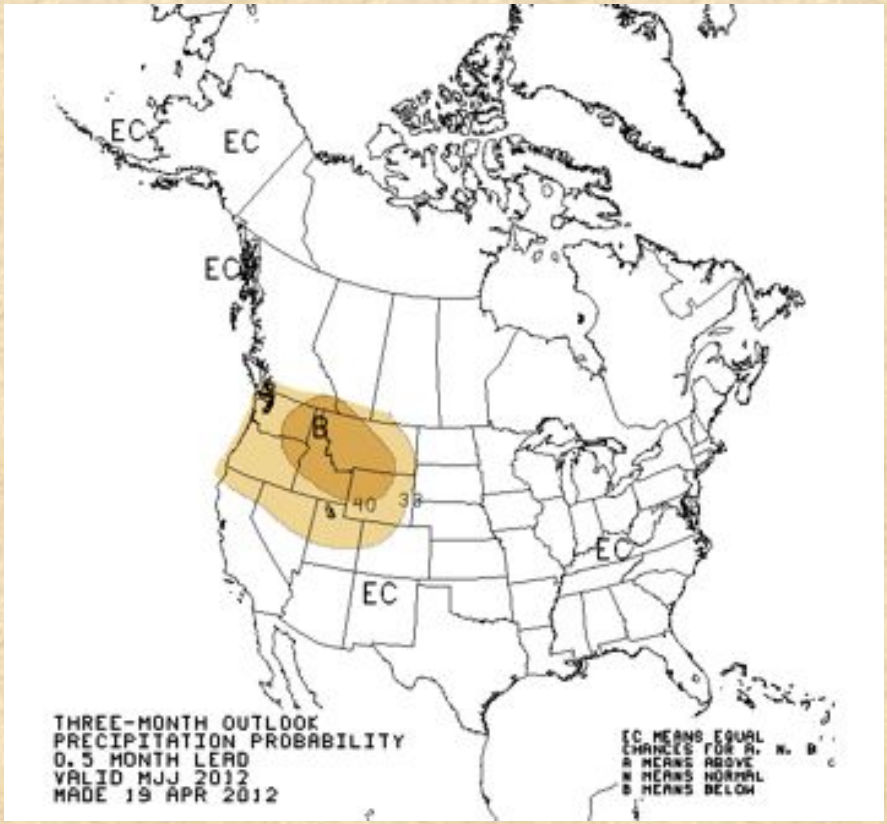


The ECMWF April 2012 forecast (right) shows an astonishing range – with a single member in the moderate-to-strong *La Niña* category (-1°C) to seven members reaching 'Super-*El Niño*-size' of +2°C or more by October 2012.

Given this range of the best forecast model, anything is possible, but its mean outcome (+1°C) is now solidly pro-El Niño

Climate Prediction Center Spring Forecasts

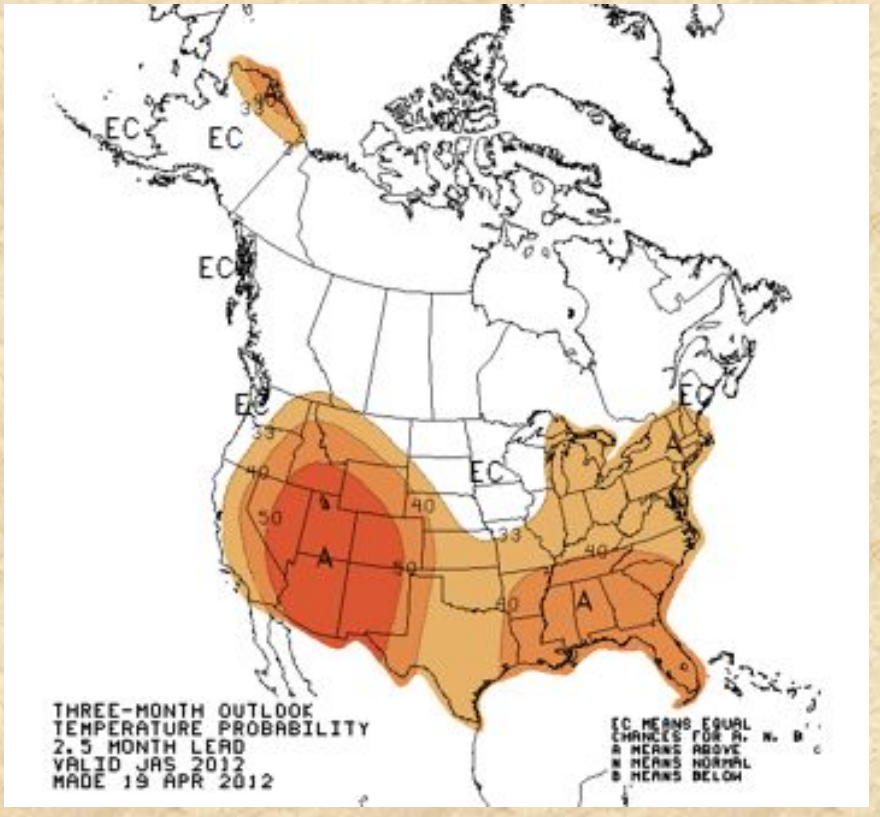


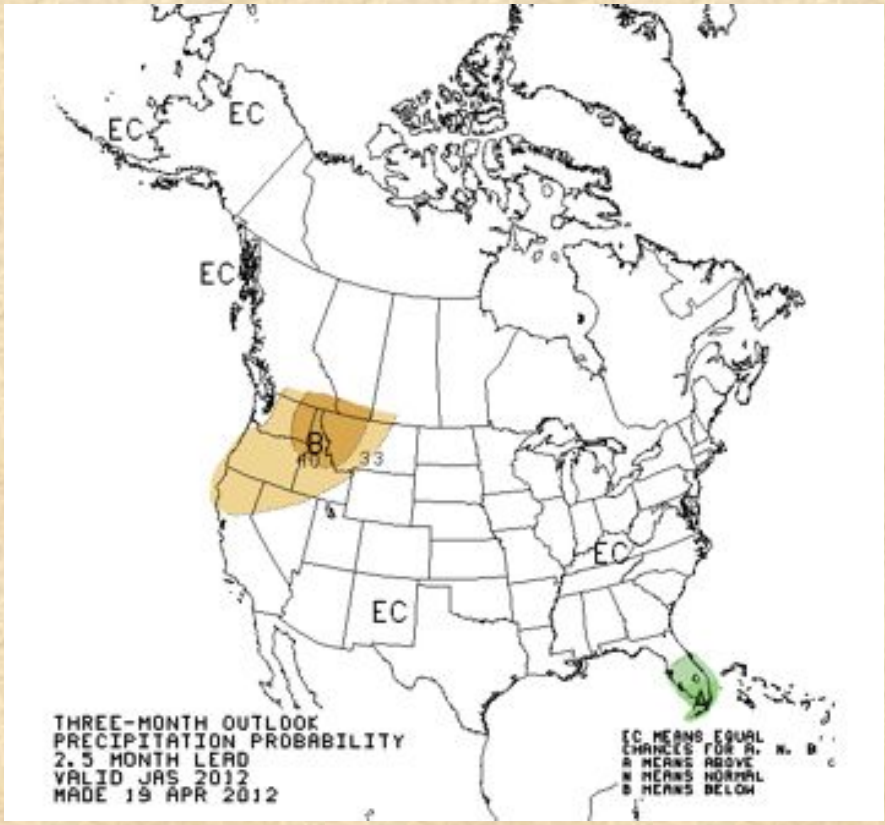


CPC's forecasts for May-July temperature (left) and precipitation (right) reflect recent long-term trends. This translates into a warm (left) forecast, but no guidance for precipitation (right) in our region of interest ('EC' means 'equal chances' or climatological odds.

Source: ***http://www.cpc.ncep.noaa.gov/products/predictions/***

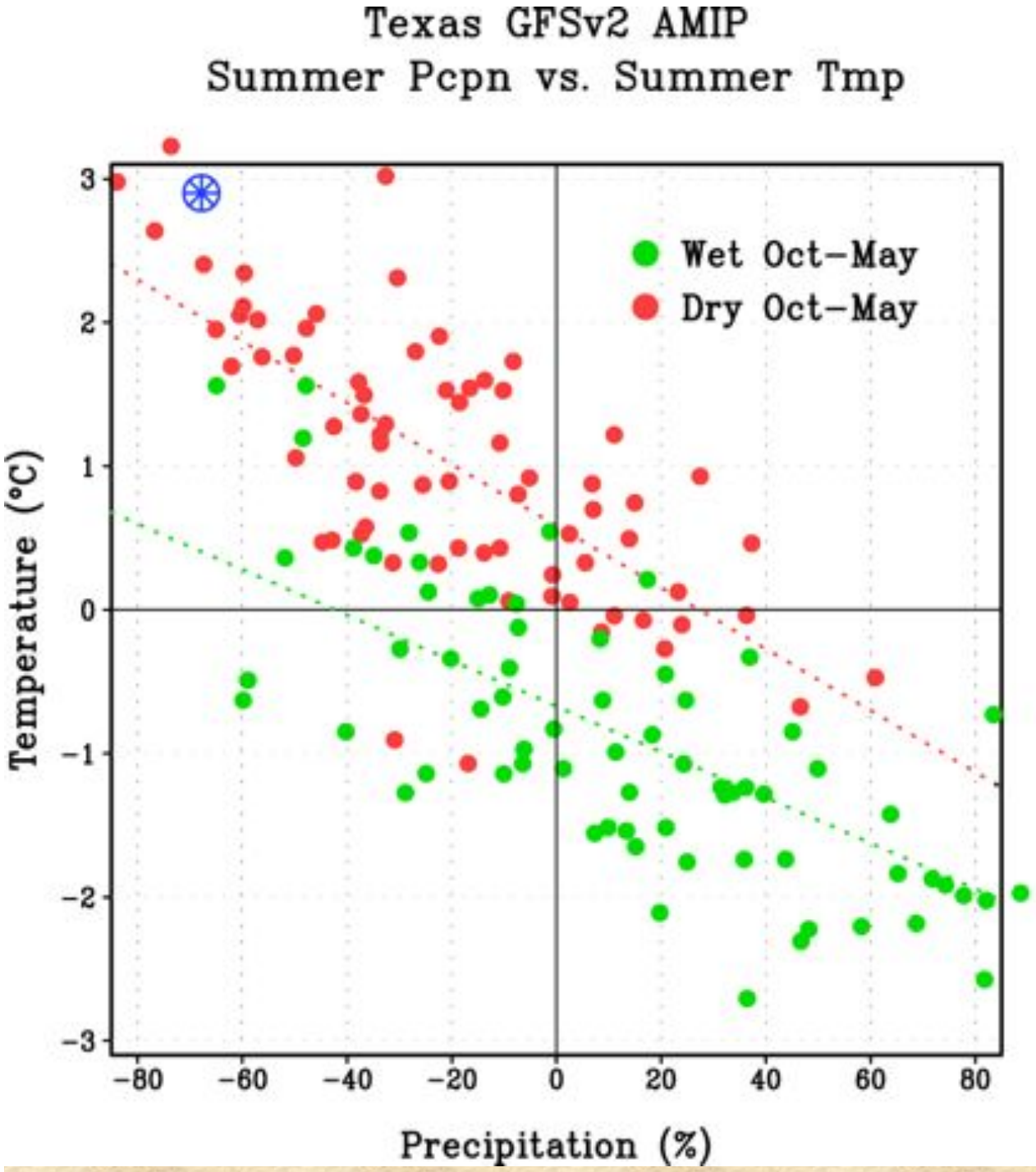
Climate Prediction Center Summer Forecasts





CPC's forecasts for July-September temperature (left) and precipitation (right) reflect recent long-term trends. This translates into a warm (left) forecast, but no guidance for precipitation (right) in our region of interest ('EC' means 'equal chances' or climatological odds. The main difference to the earlier seasonal forecast is increased coverage of warmer-than-average temperatures and decreased coverage of either category rainfall for the U.S. *Current operational skill in moisture forecasts for summer is low.*

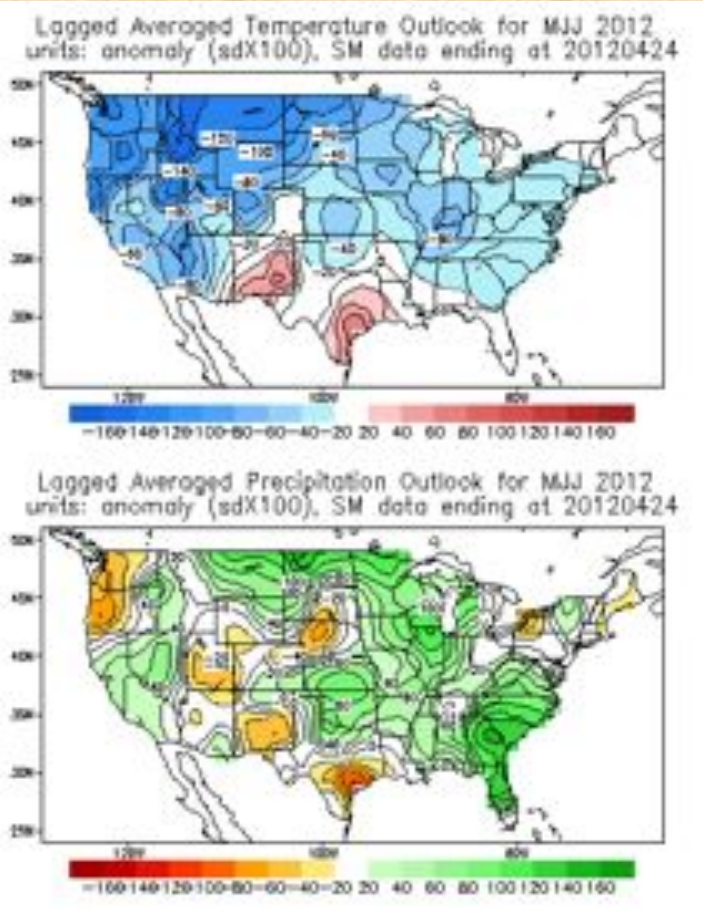
Source: ***http://www.cpc.ncep.noaa.gov/products/predictions/***

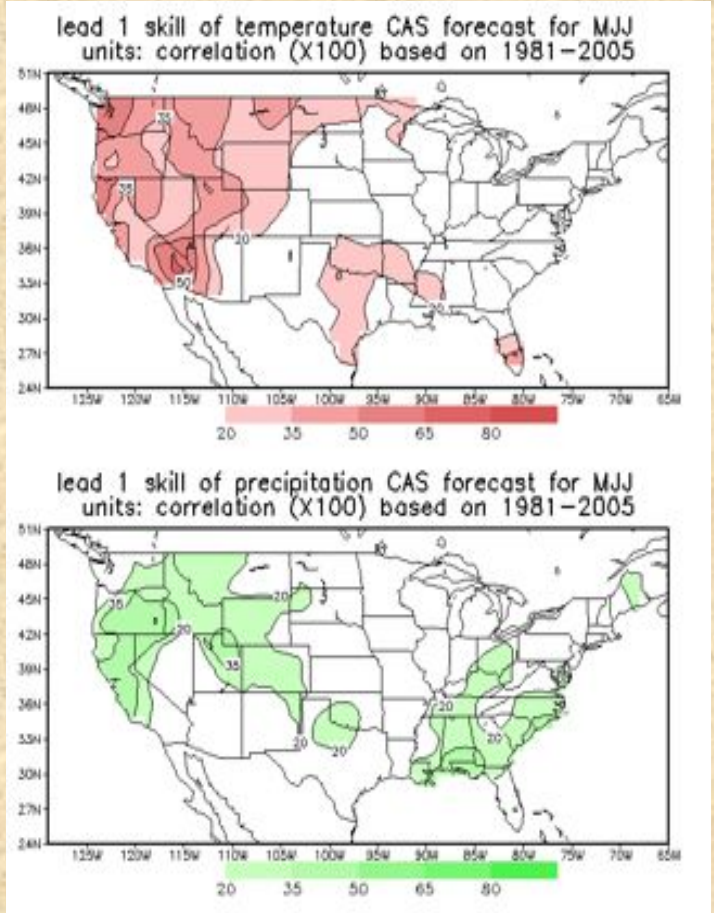


Role of preceding moisture

Source: Hoerling et al., 2012: Anatomy of a Heat Wave. J. Climate, submitted

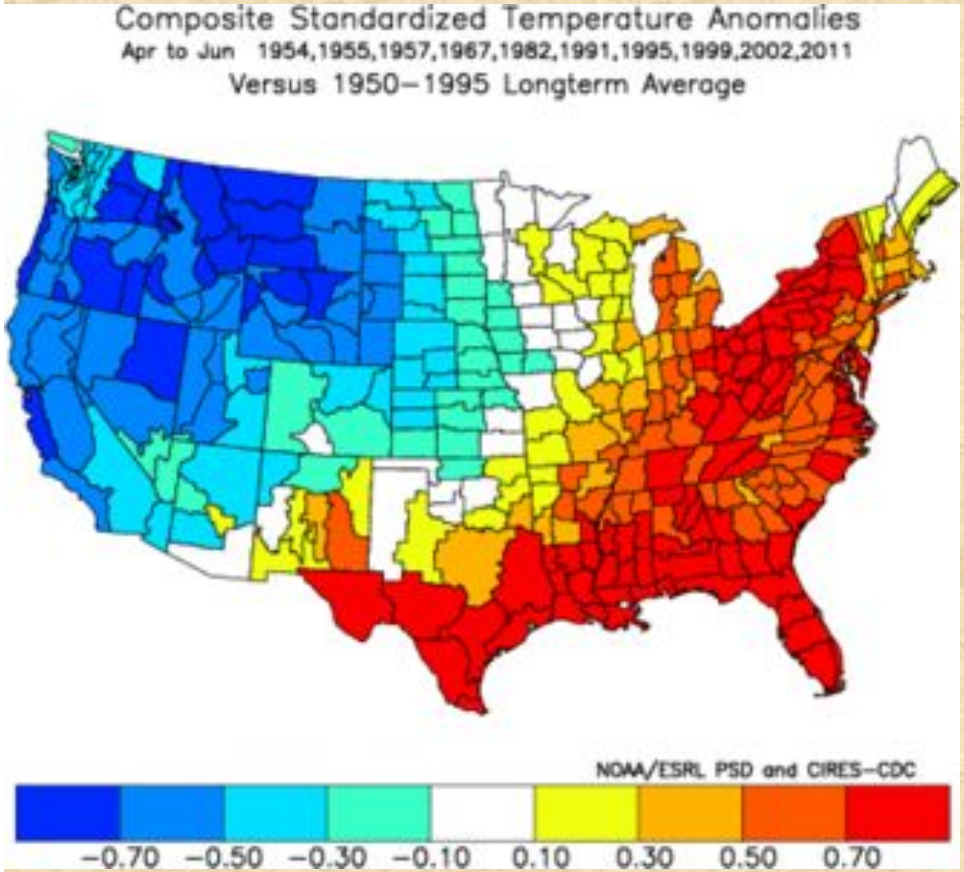
Other considerations – 'Constructed Analog'

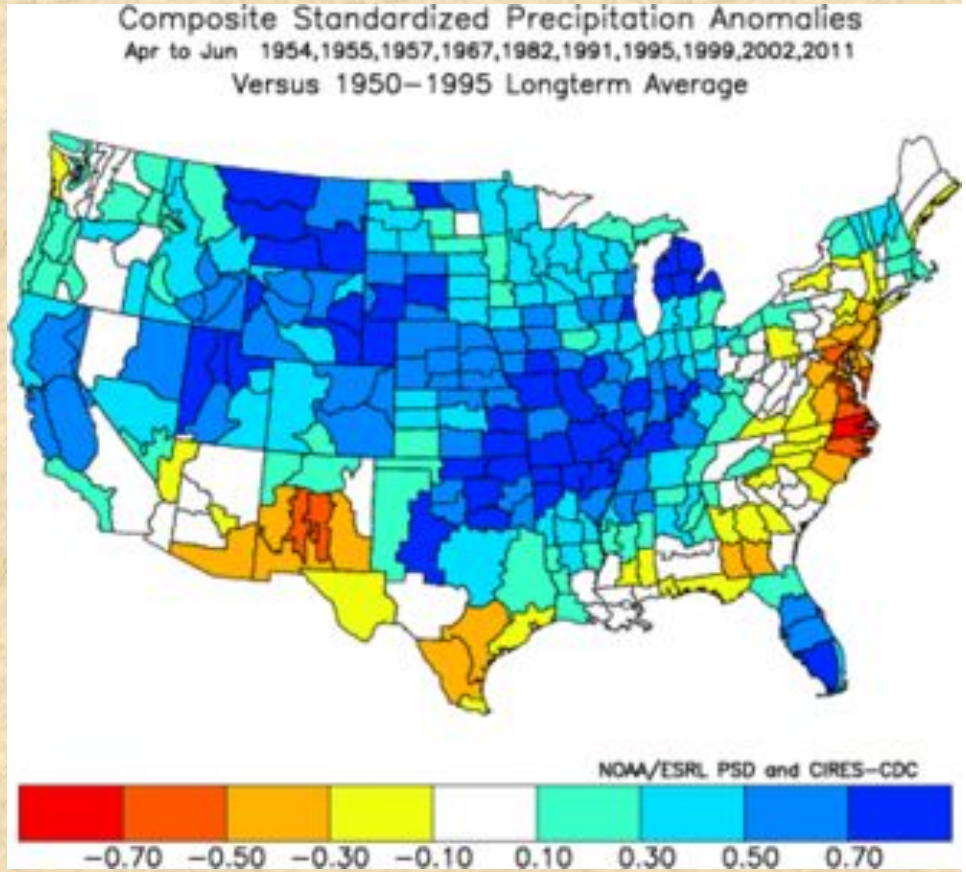




According to CPC's soil-moisture analog forecast, the next three months look dry for New Mexico and wet for northern Texas and Oklahoma (left). Skill at this lead-time (right) is better for temperature than for precipitation, showing some skill in northern Texas for precipitation. **Source**: ***http://www.cpc.ncep.noaa.gov/soilmst/cas.shtml***

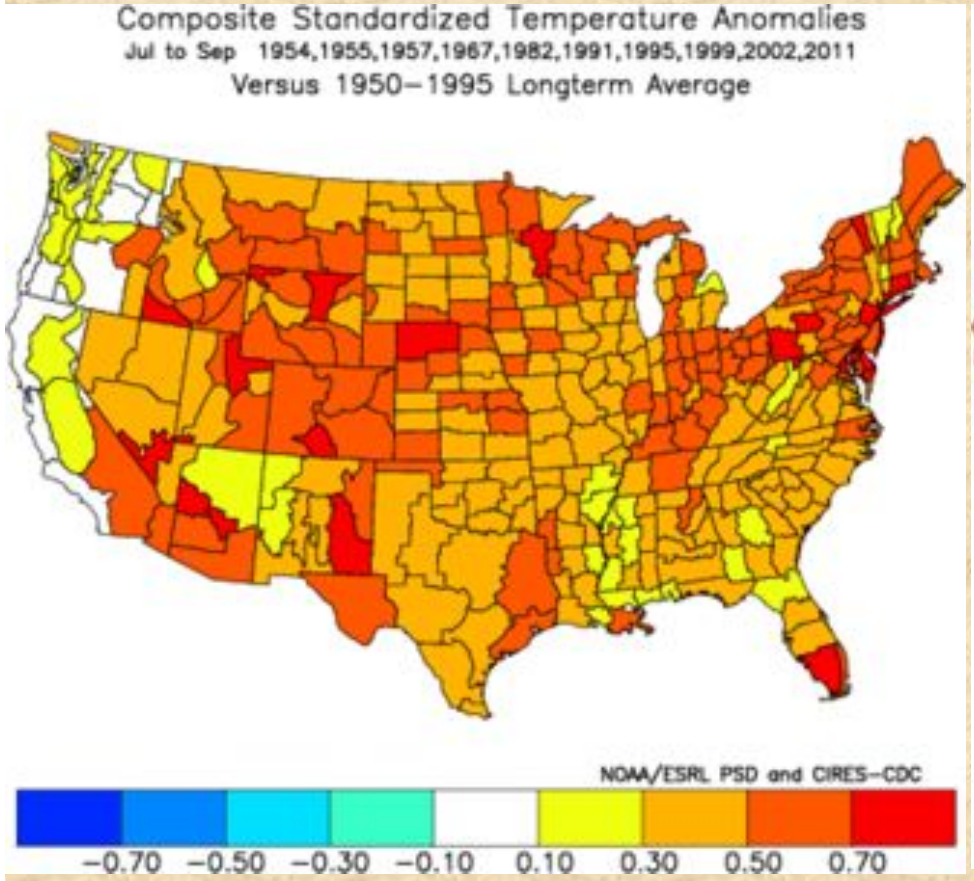
Other considerations - Warm Gulf of Mexico (≠AMO)

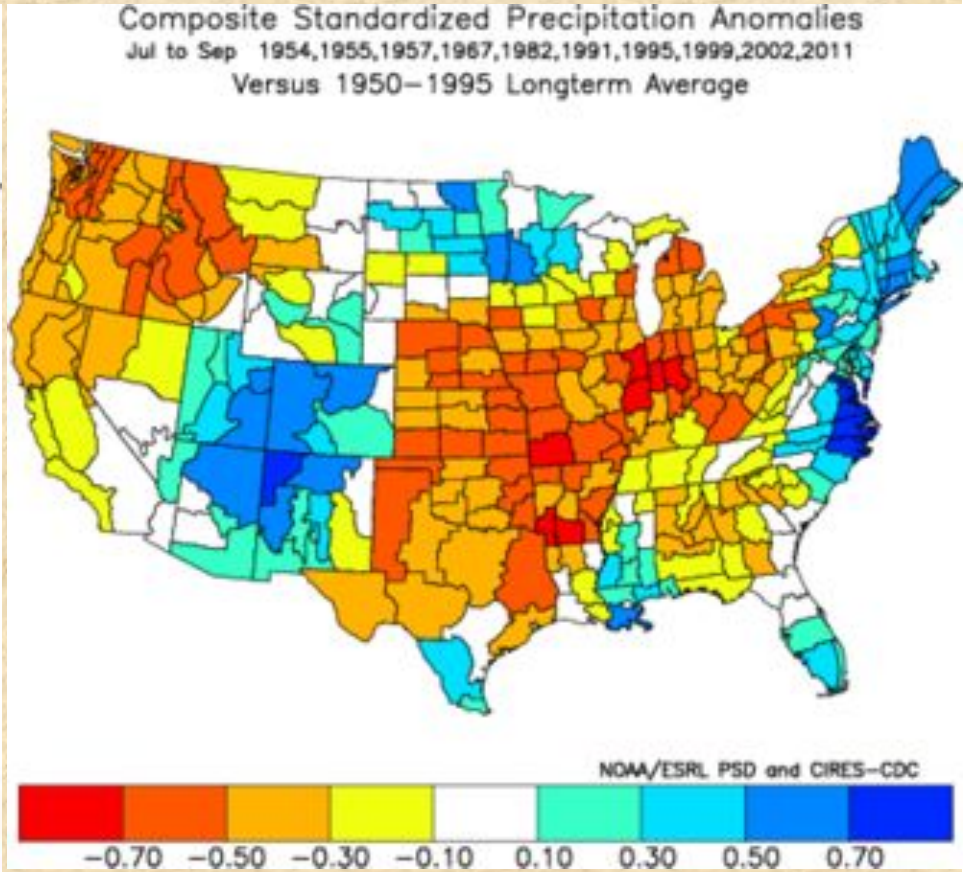




Gulf of Mexico is very warm this month (it was 10th highest in March) – if I take the Gulf average temperature over last 62 years (since 1950) and pick the 10 warmest cases in April, I get the composites shown above, *cutting across ENSO categories*, and being in the warm AMO phase 7 out of 10 times. Both 2002 and 2011 are part of this composite. For New Mexico and southern Texas, this would favor a dry spring, while northern Texas is often wet with this.

Other considerations - Warm Gulf of Mexico (≠AMO)



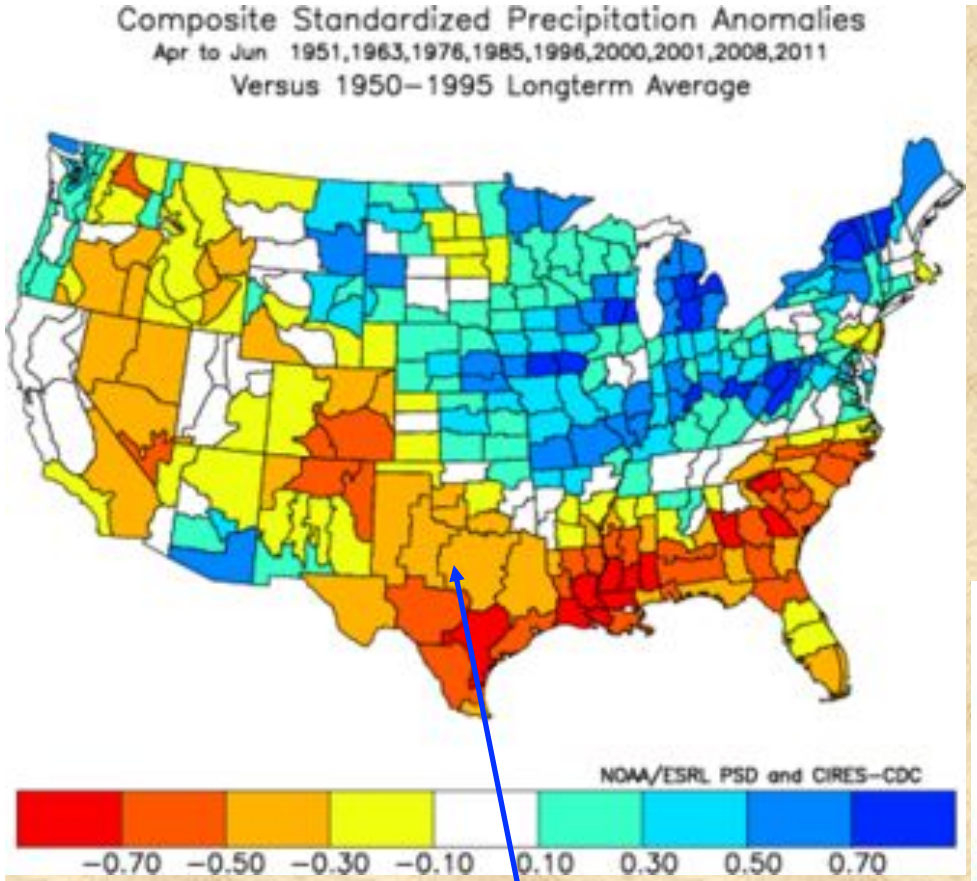


These are the composites for late summer (July-September) based on warm Gulf of Mexico SST in April (same as before). The monsoon season appears to be favored over its traditional region (into Four Corners), while Texas may see a return to drier conditions.

Scenario A (warming to ENSO-neutral) vs. Scenario B (warming to El Niño by May-June)

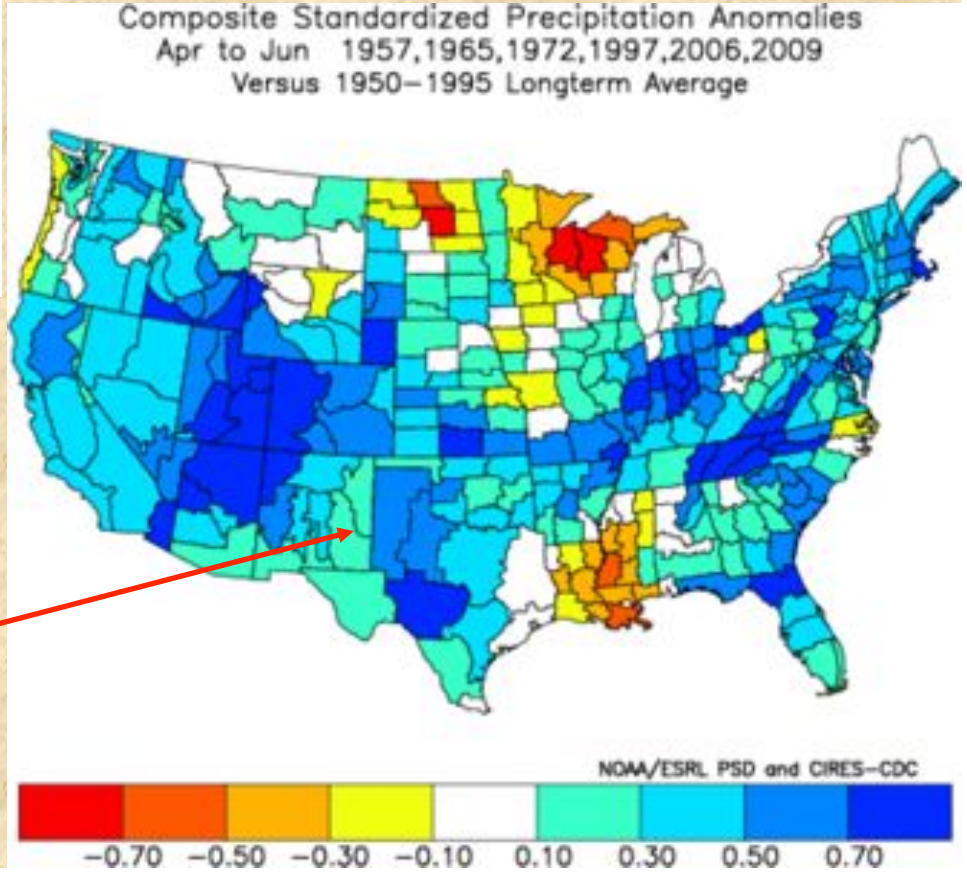
Motivation: Does it make a difference if we transition from La Niña in winter to ENSO-neutral this summer, or does a rapid transition to El Niño (by May-June in the MEI sense) entail a different average footprint in U.S.?

Post-La Niña springs

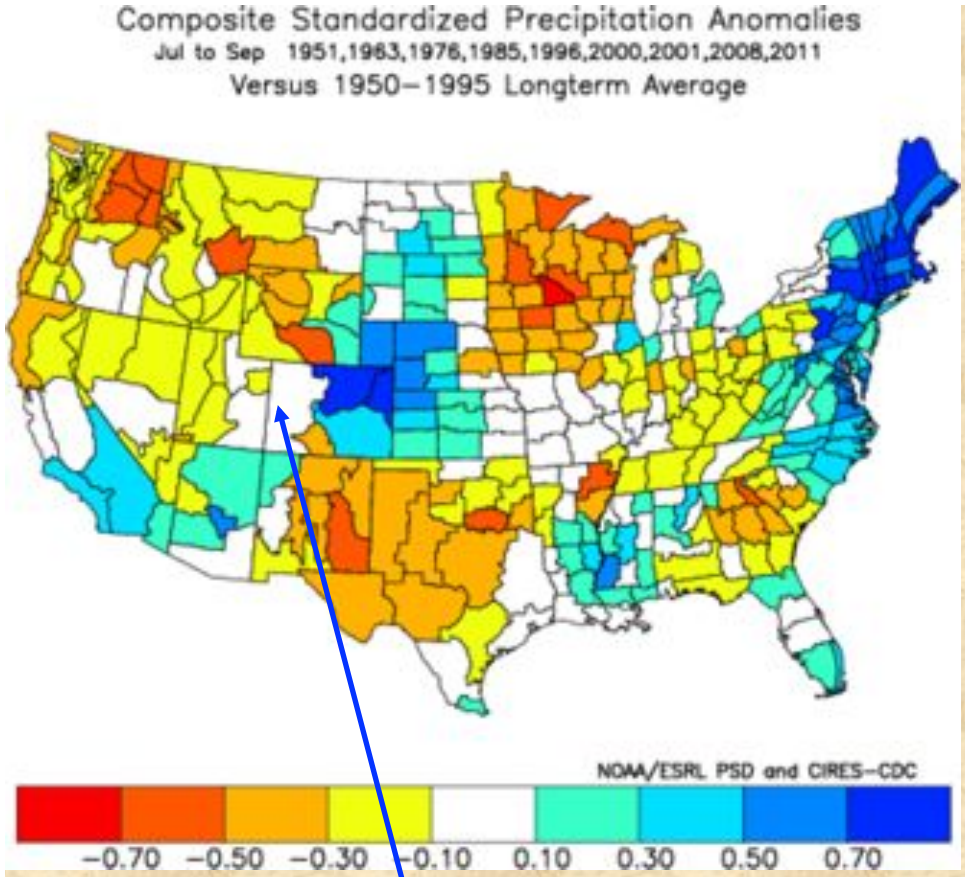


IF we go from La Niña in winter to just ENSO-neutral conditions by May-June, we tend to end up with a dry spring (top).

IF we were to reach El Niño conditions by May-June, we could get a much wetter spring (right). ***This scenario has recently become more likely, but is still less likely than ENSO-neutral.***

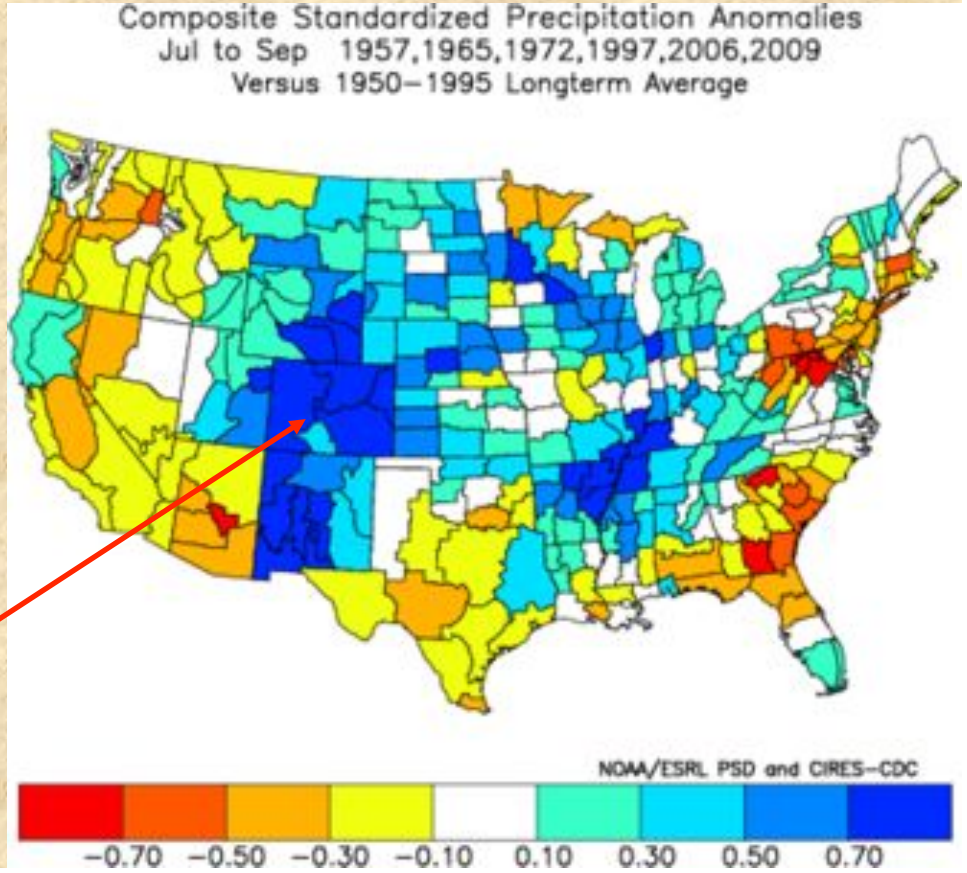


Post-La Niña summers

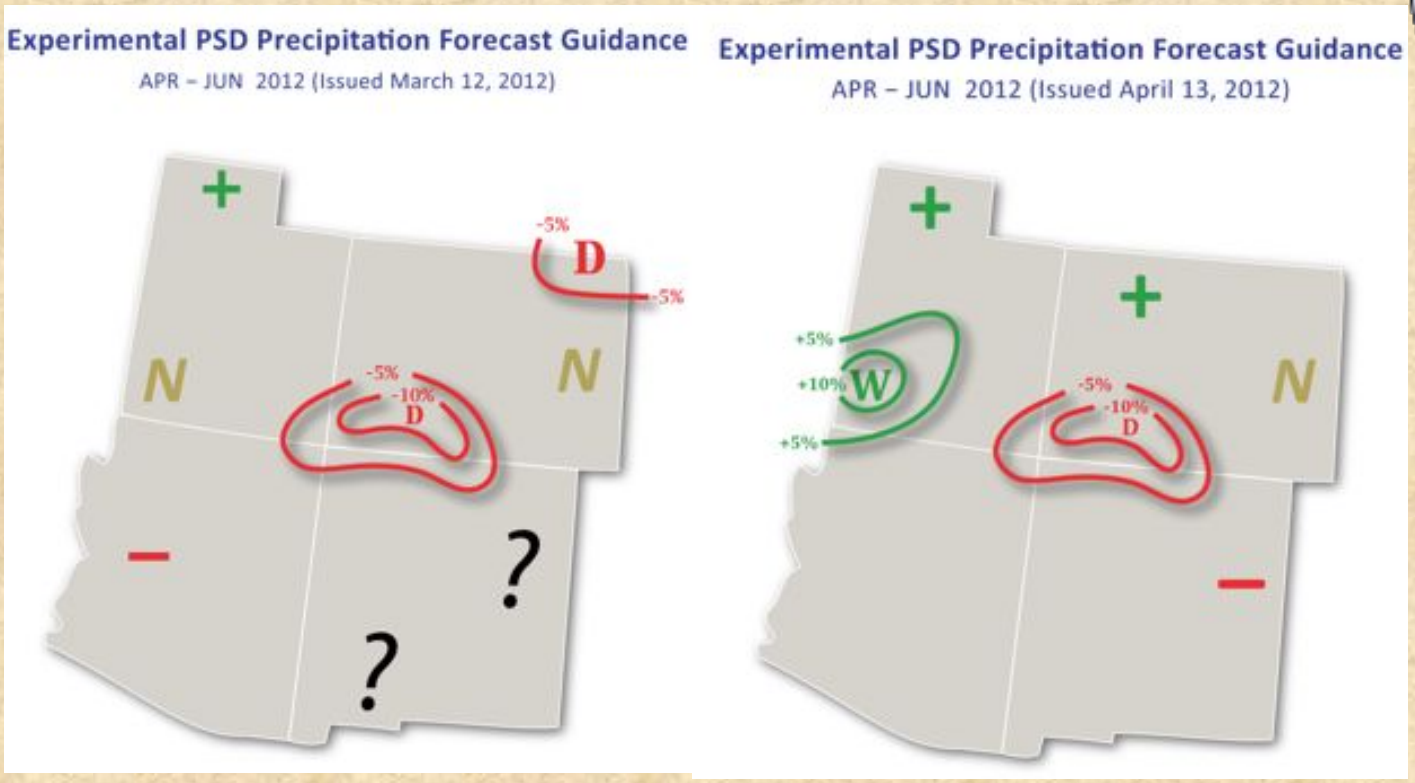


IF we go from La Niña in winter to ENSO-neutral conditions by May-June, we tend to end up with a dry summer in the south-central U.S. (top).

IF we were to reach El Niño conditions by May-June, we could get a wetter summer in New Mexico, but not in Texas (right)

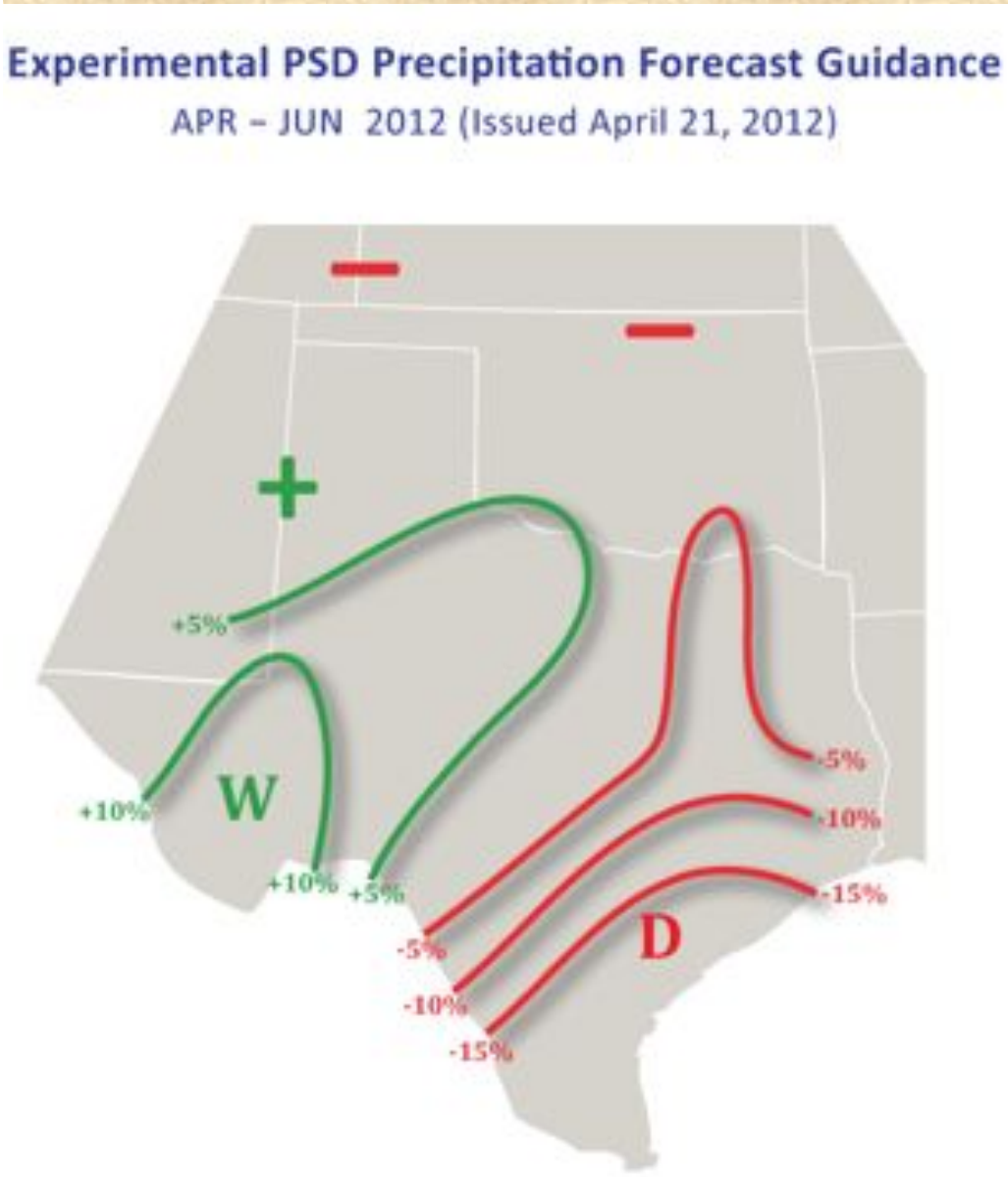


Statistical Forecast for April-June 2012



March's (left), and current (right) forecasts for April-June 2011 are fairly confident that SW Colorado into New Mexico will see below-normal moisture. The new forecast map looks a little bit more similar to the 6 La Niña-El Niño transition composite shown earlier. *Unfortunately for this meeting, skill since 2000 has been better over Utah and Colorado than over New Mexico.*

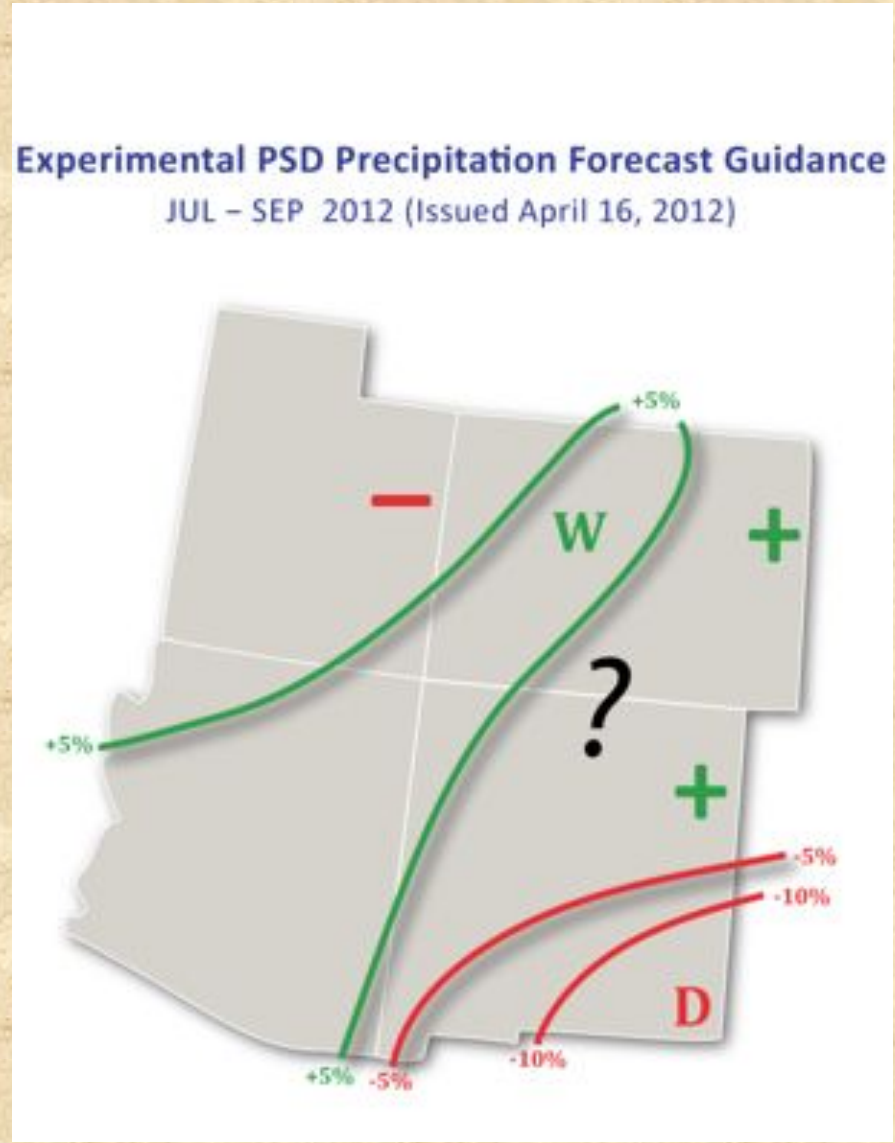
First Statistical Forecast for April-June 2012 for the South-Central U.S.



The map on the left shows the shift in the odds from normal for the spring season in Texas and Oklahoma, calibrated on the performance of similar forecasts in the last 62 years.

A similar forecast is in the works for July-September 2012 – stay tuned!

Statistical Forecast for July-September 2012



The first forecast of the year for July-September 2012 is optimistic from AZ into CO and a little parts of NM, and pessimistic for southern NM.

At this long-lead time, historical skill performance has been quite poor except for northwestern UT ('EC'), southwest NM (dry), as well as the eastern half of CO (wet).

These forecasts tend to have better skill later in spring.

Summary

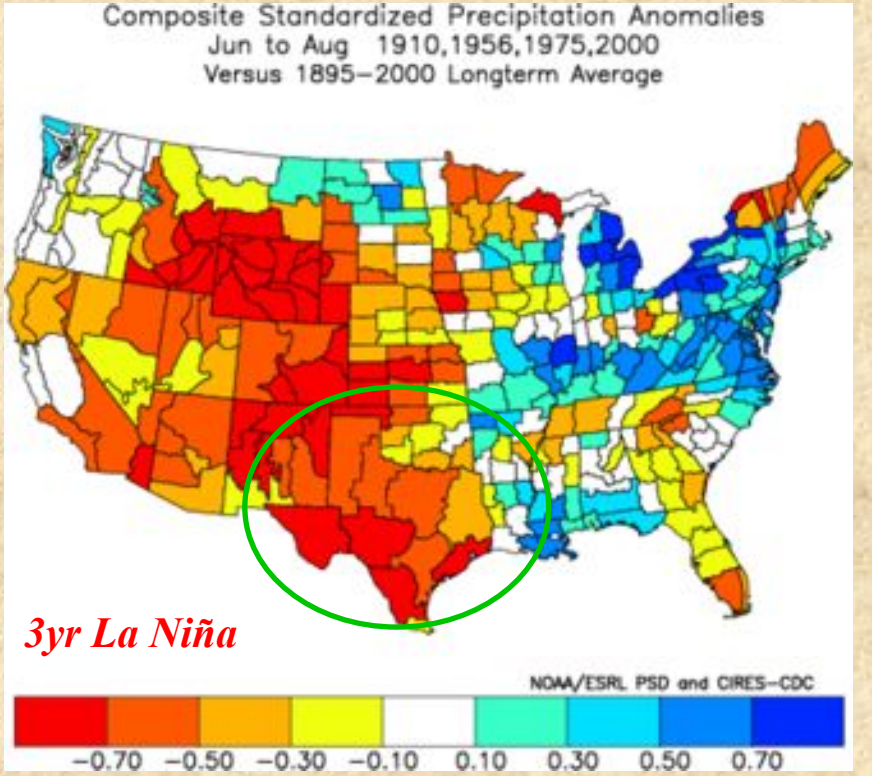
- **La Niña is on its way out; it is still uncertain how much the tropical Pacific will warm up in the next three months. If we end up with El Niño by early summer, both spring and summer tend to be clearly wetter than normalin New Mexico, while Texas and Oklahoma have at least diminished drought chances.**

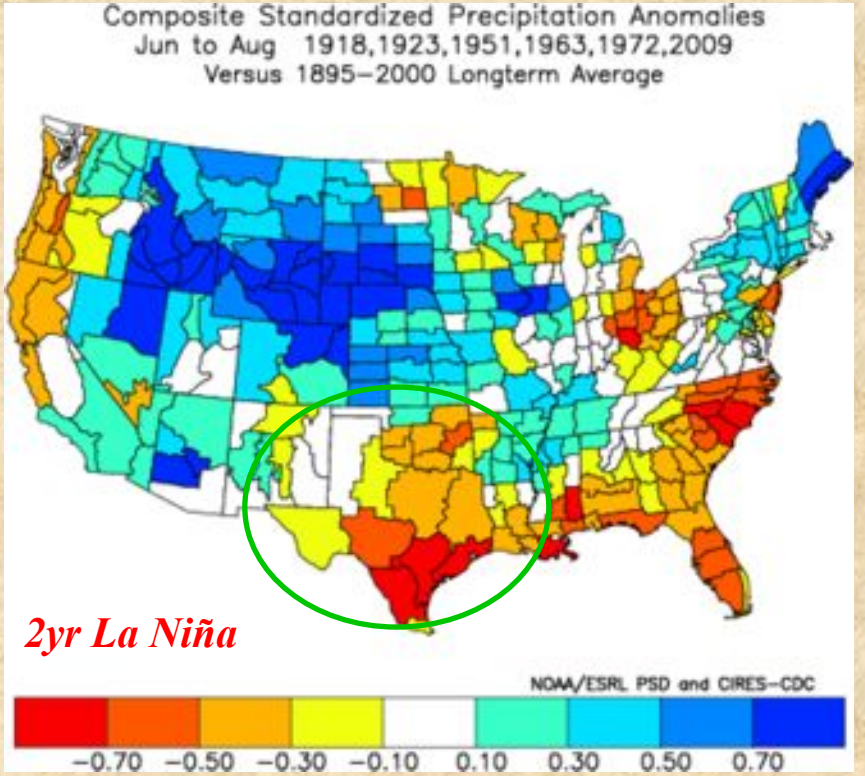
- **Considering factors other than ENSO helps to refine a spring forecast that is more favorable for moisture in northern Texas and Oklahoma, and more on the dry side for southern Texas and New Mexico. Early indications for the summer are favorable for New Mexico and not for Texas, with Oklahoma being undecided for now.**

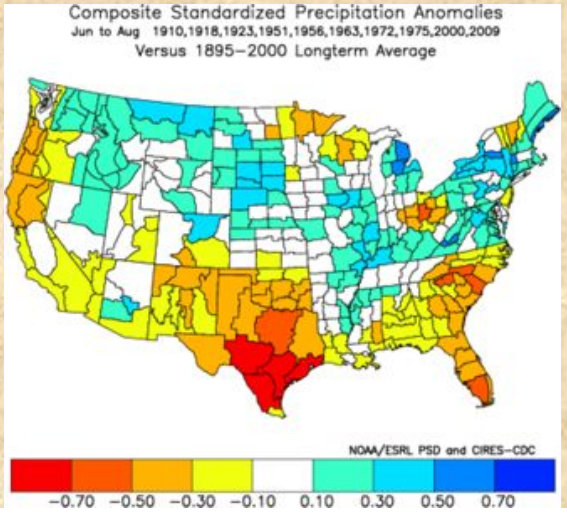
- **If La Niña were to make a comeback this fall, a return of drought conditions would be likely. At present, official forecasts of ENSO hold out for ENSO-neutral this winter. My own forecast tool leans more towards La Niña than even the 40% historical odds of returning from a two-year La Niña to a 'triple delight' La Niña.**

- ***Lots of ongoing research, and the ENSO situation should be much clearer in about two months!***

3rd summer La Niña composites

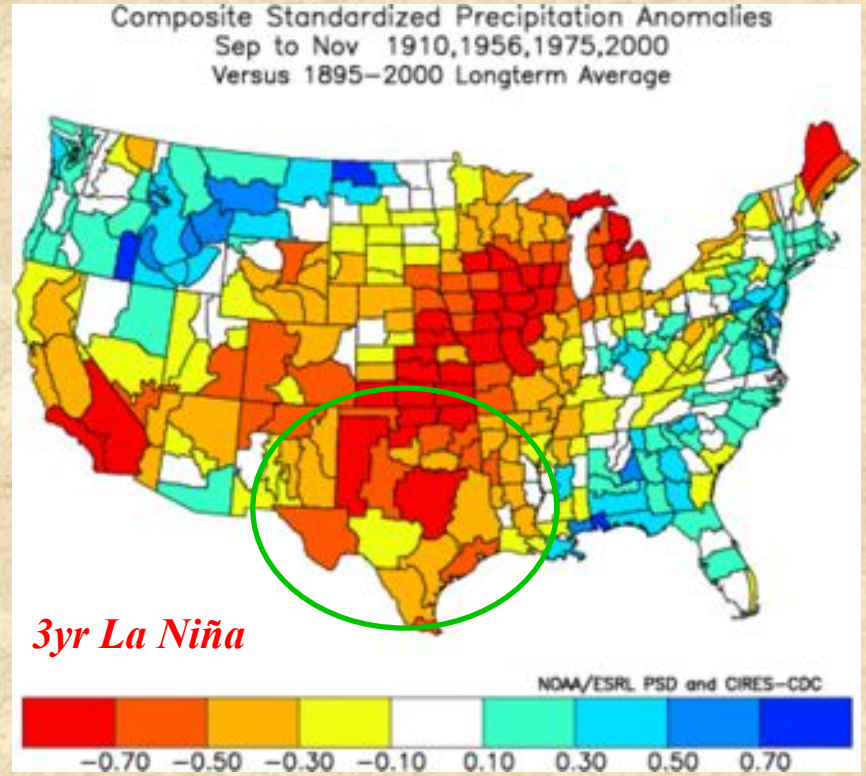


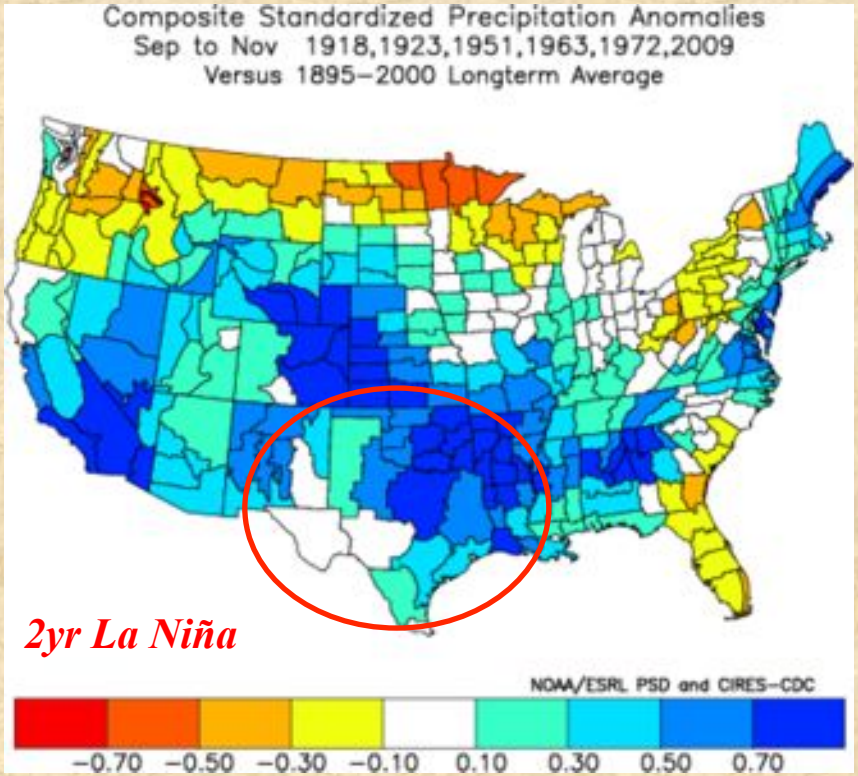


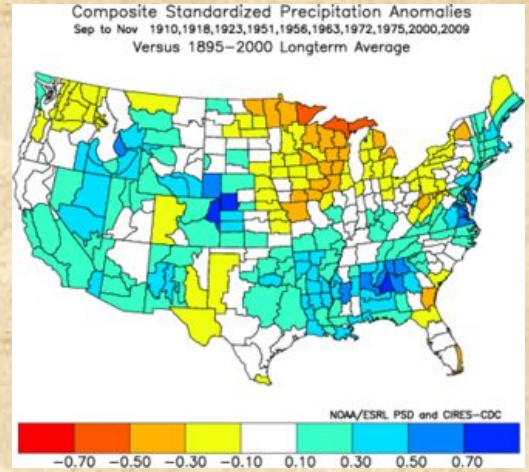


3rd year summer composite for 4 La Niña events that lasted LONGER than two years (top left), and for 6 events that ended after 2nd season (top right) – not a huge difference for our region of interest (but drier with continuing La Niña); left figure shows the average of all 10. These scenarios apply to the summer of 2012.

3rd fall La Niña composites

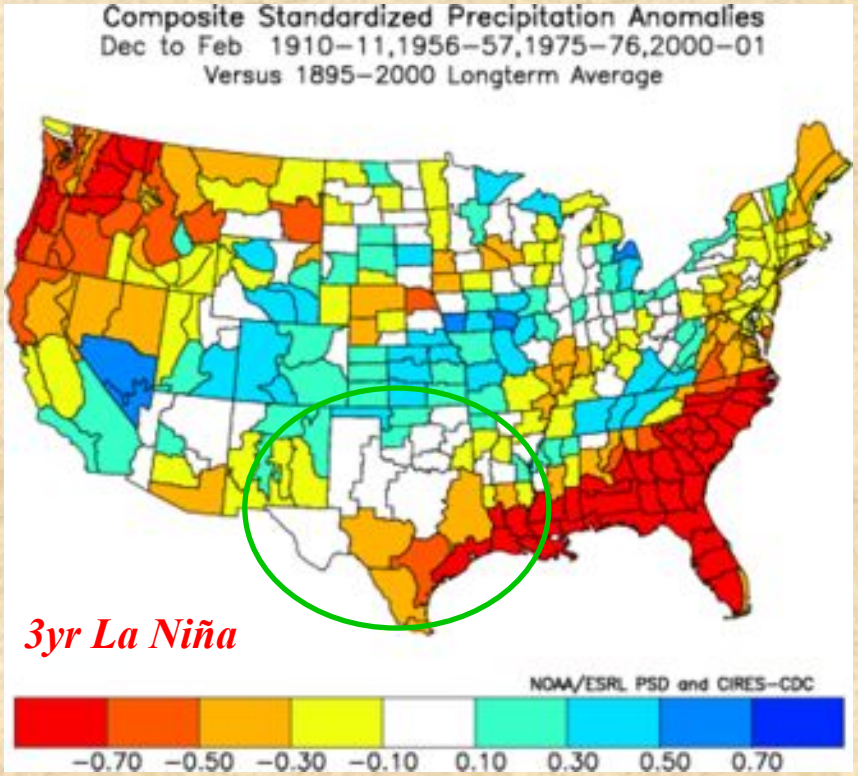


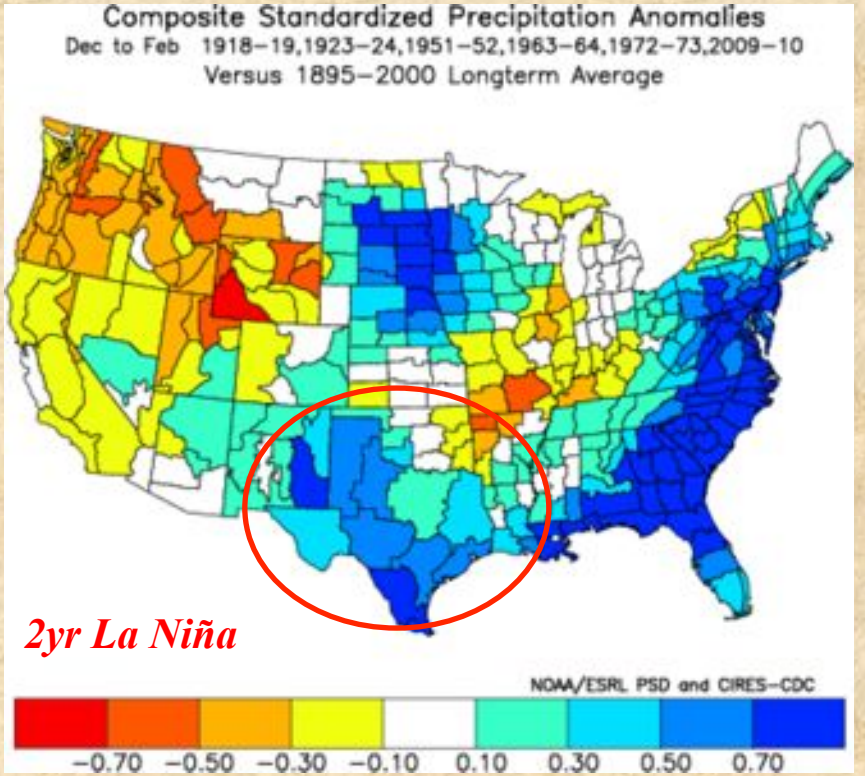


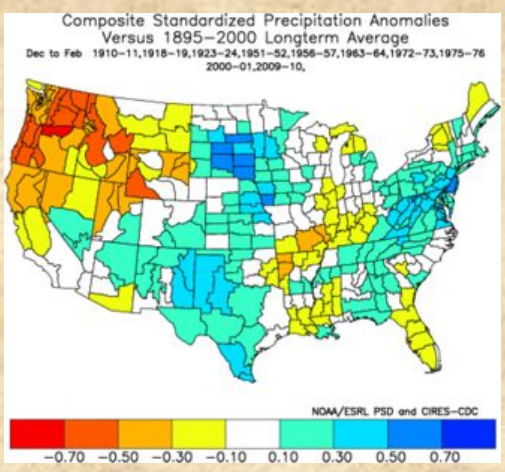


3rd year fall composite for 4 La Niña events that lasted LONGER than two years (top left), and for 6 events that ended after 2nd season (top right) – HUGE difference in south-central U.S.; left figure shows the average of all 10. These scenarios apply to the fall of 2012.

3rd winter La Niña composites







3rd year winter composite for 4 La Niña events that lasted LONGER than two years (top left), and for 6 events that ended after 2nd season (top right) – big difference for south-central U.S. continues; left figure shows the average of all 10. These scenarios apply to the winter of 2012-13.